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Foreign Direct Investment, Imports of Capital Goods, and Economic Growth in Emergent Economies.

Assessing the Technological Absorption Hypothesis, 1961-2015

Bruno Ricardo Marques Magalhães

up201500304@fep.up.pt

Supervisor: Aurora A.C. Teixeira

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Bio

Bruno Ricardo Marques Magalhães was born on 22nd November 1994, in Matosinhos, Portugal. He graduated in Economics by the University of Minho in 2015.

Presently, he is attending the Master Program in International Business at the Faculty of Economics of the University of Porto.

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Resumo

A absorção tecnológica de novas e avançadas tecnologias é amplamente entendida como sendo um motor de crescimento económico para os países tecnologicamente menos desenvolvidos, nomeadamente as Economias Emergentes (EEs). Trata-se, pois, de um processo bastante complexo devido à heterogeneidade dos países, especificamente em termos tecnológicos, produtivos e em termos socioeconómicos. As EEs podem alcançar convergência económica e tecnológica, bem como crescimento produtivo, através de investimento direto estrangeiro e de importações de bens de capital oriundos de países tecnologicamente mais avançados. Contudo, ainda não é claro, para a literatura existente, qual dos canais, Investimento Direto Estrangeiro (IDE) ou importações de bens de capital é o mais relevante para o crescimento económico das EEs, e como a capacidade de absorção (i.e., capital humano e I&D) se relaciona com o IDE e as importações de bens de capital.

O principal objetivo do presente estudo passa por contribuir para a literatura empírica da área, através da estimação do impacto do comércio, IDE e das capacidades de absorção no crescimento económico de um painel de 39 EEs no período 1961-2015. Metodologicamente, recorremos a estimativas robustas do modelo de efeitos fixos com dados em painel num período longo (54 anos, 1961-2015), intermédio (19 anos: 1996-2015) e curto (10 anos: 2005-2015). Além disso, acomodamos a habitualmente negligenciada heterogeneidade entre países, através da análise da capacidade de absorção das 39 EEs de acordo com o seu nível de rendimento e grupo geográfico.

Os resultados das nossas estimações enfatizam a importância das importações de bens de capital e dos fluxos de entrada de IDE no crescimento económico no modelo de base de período longo (1961-2015). Ademais, para os períodos mais recentes (1996-2015 e 2005-2015), as principais alavancas de crescimento para as EEs são a capacidade de absorção, mais concretamente, a interação entre capital humano/I&D, e os fluxos de entrada de investimento direto estrangeiro. Tais resultados vão ao encontro das expectativas da literatura de que o capital humano e o investimento doméstico em I&D facilitam o processo de absorção de spillovers oriundos do IDE. Finalmente, esta pesquisa, também, revela a existência de uma profunda heterogeneidade entre as trajetórias de crescimento dos EEs, através de uma análise detalhada dos determinantes de crescimento de longo prazo, por grupo de rendimento e região geográfico.

Palavras-chave: Economias Emergentes; Crescimento económico; Importações de bens de capital; IDE; Capital humano; I&D

Códigos JEL: F00; F10; F14; F21; I20; O10; O30.

Abstract

The technological absorption of new frontier technologies is widely perceived as an engine of economic growth for the least technical developed countries, namely the Emerging Economies (EEs). It is a rather complex process due to the associated country-specific heterogeneity on technology, production, and socioeconomic factors. EEs tend to achieve economic and technological convergence and productivity growth through foreign direct investment and by importing capital goods from more technological advanced countries. However, it is not yet clear, for the existing literature, which channel, FDI or trade, is the most relevant for EEs' economic growth, and how these countries' absorptive capacities (i.e., human capital and R&D) relates to FDI and trade in this regard.

The main aim of the present study is to contribute to the empirical literature in the area by estimating the impact of trade, FDI, and absorptive capability on the economic growth of a panel of 39 EEs over an extended period, from 1961 to 2015. Methodologically, we resorted to robust estimations of fixed effects panel data models over a long (54 years: 1961-2015), intermediate (19 years: 1996-2015) and a short (10 years: 2005-2015) period. Furthermore, we accommodate the often neglected heterogeneity between countries by analysing the absorptive capacity of the 39 EEs according to their income level and geographical groups.

The results of our estimations emphasise the importance of imports of capital goods and inwards FDI flows on economic growth in the *baseline* extended model (1961-2015). Moreover, for the most recent periods (1996-2015 and 2005-2015), EEs' most important growth promotors are the absorptive capacities, most notably the interaction between human capital/R&D, and foreign direct investment inflows. These results meet the expectations of extant literature that human capital and domestic investments in R&D facilitates the absorption process of spillovers that come from FDI. Finally, this research also unveils the existence of a profound heterogeneity among EEs' growth trajectories by providing an in depth analysis of long run growth determinants by group of income and world regions.

Keywords: Emergent Economies; Economic growth; Imports of capital goods; FDI; Human capital; R&D

JEL-Codes: F00; F10; F14; F21; I20; O10; O30.

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1. Introduction

International technological catching-up is an important vehicle to promote productivity and economic growth (Krammer, 2010). Extant literature (e.g., Krammer, 2010; Glas, Hübler, and Nunnenkamp, 2016) have found that political and economic openness to trade and the inflows of FDI are important to accelerate technological transfer and foster countries' (total factor) productivity growth. However, as far as empirical studies go, imports of capital goods and inflows of foreign direct investment are not enough on their own to close the technological gap.

Analyzing forty-seven (transition and developed) countries, Krammer (2010) found that in order to benefit from knowledge spillovers, economies need to possess a given level of human capital and domestic investment in Research and Development (R&D). In other words, total factor productivity is heavily influenced by the level of human capital which affects the 'absorptive capacity' of a nation (Xu, 2000; Krammer, 2010; Teixeira and Fortuna, 2010). Indeed, several authors highlighted the importance of human capital and domestic investments in R&D for advanced and emerging countries in their absorption process of spillovers that come from trade (Teixeira and Fortuna, 2010; Banerjee and Roy, 2014) and FDI (Li and Liu, 2005; Baharumshah and Almasaied, 2009; Su and Liu, 2016).

Improvements in human capital are, according to Saccone (2017), one of the main contributors to economic growth in 'emerging economies' (EEs) and governments should promote internal capacity-building activities (such as human capital and R&D) to meet the economic and social challenges that the populations of these countries face (see Azam and Ahmed, 2015). According to Glas et al. (2016), EEs tend to achieve economic and technological convergence and productivity growth through two main channels: foreign direct investment (FDI), and international trade (specifically, by importing capital goods from more technological advanced countries). However, so far, the extant studies fail to clarify which of the three factors/channels - FDI, trade, or absorptive capacity (i.e., human capital and R&D) - are the most relevant for economic growth in EEs, and how absorptive capacity relates to FDI and trade in this regard.

The present study aims at fill in this gap, by testing the technological absorption hypothesis, that is, by assessing the extent to which human capital and R&D (i.e., country’s absorptive capacity) interact with trade and FDI and impacts on long run economic growth of EEs.

Additionally, and although there are some studies that have already analyzed the process of EEs’ technological catching-up (e.g., Banerjee and Roy, 2014; Glas et al., 2016; Su and Liu, 2016) such studies do not explore EEs’ heterogeneity. Specifically, they tend to analyze only a very specific group of large EEs, the BRIC (Brazil, Russia, India, and China) as a whole (see Glas et al., 2016), or focusing on one of these countries individually (India - Banerjee and Roy, 2014; China - Su and Liu, 2016).

The present dissertation aims also to fil this empirical gap, by providing insights on how absorptive capacity, international trade and FDI can influence the technological catching-up process not only of the whole set of EEs, but also considering distinct groups (income poorer, intermediate, and richer) of EEs over the last five decades.

In methodological terms, we resort to econometric models by employing fixed effects panel models including 39 EEs (as classified by Saccone (2017)), over the period 1961 - 2015, to disclosure the nature of the impact of absorptive capacity and technology transfer on economic growth.

The present dissertation is structured as follows. In the next section, a literature review containing the theoretical framework and empirical data that sustain our presumptions about the impacts of technology diffusion on economic growth. In Section 3, we describe the methodology of our estimations. Then, in Section 4, we analyze the obtained results. Finally, in Section 5 we conclude the study by highlighting the main outcomes and the limitations of our research.

2. Literature review on trade, FDI, absorptive capacity and long-run economic growth. Main hypotheses to be tested

2.1. Trade and and long-run economic growth

Trade, most notably the imports of machinery and equipment, is an important carrier of technological development through spillovers, vital to less developed countries' growth (see Fagerberg, 1994; Coe, Helpman, and Hoffmaister, 1997; Krammer, 2010).

Existing empirical literature focused on developing (e.g., Dulleck and Foster, 2008; Cuadros and Alguacil, 2014) and emergent (e.g., Banerjee and Roy, 2014; Glas, Hübler, and Nunnenkamp, 2015) countries concludes that imports of capital goods have a significant positive impact on these countries' economic growth through increases on total factor productivity. Krammer's (2010) research further suggests that trade brings benefits for all types of countries, stating that less developed, developing and developed countries can all reap large benefits from trade.

The research by Coe et al. (1997) have emphasised the importance for developing countries of absorbing foreign R&D, included in imported capital goods, to help those countries to reverse their technological backwardness and foster economic growth. Due to these countries' internal scarcity of R&D, the North-South trade represents an opportunity for them to receive advanced technology created by more advanced, industrialized countries.

Emerging economies (EEs) use the trade of intermediate goods as a channel to acquire new frontier technology, being later introduced in their production processes as technological advanced inputs, which then results in the development of new products and new skills and competences (Lemoine and Ünal-Kesenci, 2004). For instance, the imports by China of parts and components resulted in technological transferences and further absorptions that developed their 'assembly activities' by acquiring technological advanced inputs abroad, and thus becoming capable of improving their final product and export high-tech products (Lemoine and Ünal-Kesenci, 2004).

Considering the above, international trade contributes to economic growth, and more specifically to total factor productivity growth, namely through the imports of machinery and equipment from more technological advanced countries (Fagerberg, 1994; Coe et al., 1997; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014). Such acquisitions of foreign technological advanced machinery and equipment allow less developed countries to potentially benefit from knowledge spillovers (Teixeira and Fortuna, 2010) through the acquisition of disembodied and embodied technology (Banerjee and Roy, 2014). Thus, openness to imports of capital goods facilitates the absorption of international frontier technology and is an important vehicle to achieve productivity and economic growth (Lee, 1994; Krammer, 2010; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014; Cuadros and Alguacil, 2014), as well as, income convergence among countries (Ben-David, 1996).

In other words, trade liberalization allows imports of capital goods to work as a channel of technology diffusion and competitiveness building factor for less developed countries, having a positive impact on economic growth (Lee, 1994; Hendricks, 2000). However, this variable alone might not be capable of expanding a country's innovation progress process (Fu, Pietrobelli, and Soete, 2011). The impact of the imports of capital goods on economic growth is likely to be associated with other productivity and economic growth enhancer explanatory variables such as investment in physical capital (Fagerberg, 1994), human capital (Dulleck and Foster, 2008), indigenous R&D efforts (Fu et al., 2011), and domestic conditions, such as intuitional and socioeconomic developments (Cuadros and Alguacil, 2014).

For less developed countries to absorb the technology embodied in imports it is necessary, in parallel, to build technological domestic knowledge and capacities driven by indigenous R&D investments (Fu et al., 2011) and human capital (Dulleck and Foster, 2008) to learn, assimilate and replicate the technology embodied in the imported capital goods. This implies that technology diffusion through trade cannot be successful on its own, but it is rather the result of a complementary relation between the internal converge efforts to develop internal absorption capacities plus the international spillovers that come from foreign frontier technology.

Taking into account the above arguments, we conjecture that:

H1: EEs that import more capital goods from technological advanced countries tend to present higher growth rates.

H1a: The higher the EEs' human capital stock, the stronger the impact of capital goods from technological advanced countries on EEs' economic growth.

H1b: The higher the EEs' R&D intensity, the stronger the impact of capital goods from technological advanced countries on EEs' economic growth.

2.2. Foreign direct investment and and long-run economic growth

Foreign Direct Investment (FDI) is defined as "a category of cross-border investment made by a resident entity in one economy (the direct investor) with the objective of establishing a lasting interest in an enterprise (the direct investment enterprise) that is resident in an economy other than that of the direct investor" (OECD, 2008: page 17).

This cross-border investment tend to have a positive impact on productivity and economic growth (e.g. ; Li and Liu, 2005; Batten and Vo, 2009; Wang, 2009; Kramer, 2010; Su and Liu, 2016) by promoting capital formation and technological improvements (Wang, 2009) and is often seen as a necessary condition for the economic and technological development of developing countries, emerging economies and economies in transition (OECD, 2002) through international diffusion of spillover effects and productivity improvements (Wang, 2009).

Empirical research on emerging markets yields mixed results on the *direct* impact of FDI on economic growth in recipient developing countries, emerging economies and countries in transition. Indeed, even though most of studies found a positive correlation between FDI spillovers and economic growth (Blomström and Persson, 1983; Nair-Reichert and Weinhold, 2001; Buckley, Clegg, and Wang, 2002; Li and Liu, 2005; Wei and Liu, 2006; Baharumshah and Almasaied, 2009; Wang, 2009; Kramer, 2010; Cuadros and Alguacil, 2014; Su and Liu, 2016), others found a negative correlation (Borenztein, Gregorio, and Lee, 1998; Konings, 2000; Mencinger, 2003), or even an non-existent relation between FDI and economic growth (Haddad and Harrison, 1993; Carkovic and Levine, 2002; Falki, 2009). The contradictory results of these empirical studies might be attributed to the different causes, such as the measurements used by researchers to capture foreign presence (Buckley et al., 2002), or errors in the estimation method (Nair-Reichert and Weinhold, 2001). Ozturk (2007) suggests that empirical studies focusing on less developed countries are more likely to observe a positive impact of FDI on growth.

The theoretical framework that provides the foundation for empirical studies concerning the impact of FDI on economic growth is associated with the neoclassical and the endogenous growth models (Ozturk, 2007). The neoclassical growth theory limits the effect of FDI to the short-run, so that, in the long-run, under the assumption of diminishing returns of capital, FDI would not affect the long-run economic growth, as the host country's economy converges to the steady state, leaving to the permanent technological shocks the role of promoting growth (De Mello, 1997). In the endogenous growth theory, FDI promotes economic growth through capital formation, technology transfer, and by building new stocks of knowledge in the recipient economy, which occurs through labor training and skill acquisition (Ozturk, 2007; Forte and Moura, 2013).

For the endogenous growth models, technology transferences are the main drivers of positive externalities resultant of foreign presence in less developed countries (OCDE, 2002; Forte and Moura, 2013). Multinational corporations, regarded as highly technologically advanced firms and world leaders in investments in research and development (R&D) activities (Borensztein et al., 1998; OCDE, 2002; Wei and Liu, 2006) are crucial to spread technology world-wide, thus transforming FDI into an important vehicle of technology improvement to developing countries by promoting the transmission of advanced technologies and managerial skill (Borensztein et al., 1998; Forte and Moura, 2013). Borensztein et al. (1998) suggest that FDI is likely to be the main channel of technology diffusion for developing countries because of its higher efficiency when compared to domestic investment.

Among the major channels of technology transfer - vertical linkages with suppliers or purchasers in the host countries, horizontal linkages with competing or complementary companies in the same industry, migration of skilled labor, and the internationalization of R&D -, the vertical “backward” linkages with local suppliers in developing countries are the ones that generate more significant positive technological transferences (OCDE, 2002) and productivity spillovers (Javorcik, 2004). This is a consequence of the relation between MNEs and local suppliers, which might result in management training and assistance in the production process, quality control, acquisition of intermediate products and new clients (OCDE, 2002; Javorcik, 2004).

The presence of multinational firms also contributes to enhance human capital formation by providing training to the local labor force (Borensztein et al., 1998; Teixeira and Lehmann, 2014), although a higher public education promoted by local authorities has a bigger impact in raising the internal knowledge and skill levels of the labor force (OCDE, 2002).

The empirical studies that support the positive effect of FDI on the economic performance of the recipient country, pointed out the fact that foreign technology frontier capital has a positive significant impact on domestic firms through productivity and non-productivity spillovers (development of high-tech new products) (Teixeira and Shu, 2012) and by enhancing local competitiveness (Buckley et al., 2002). Indeed, the entrance of foreign investors in emerging markets accelerates technology and knowledge diffusion to domestic firms through the creation of externalities and spillovers, enhanced by the acquisition of participations on the capital of domestic firms and the development of financial markets (Konings, 2000; Manole and Spatareanu, 2014). Foreign investments permit the strategic restructuring and upgrading of equipment and production processes and the introduction of new products and processes (Konings, 2000; Un, 2016).

In emerging markets, the degree of the effects of technological spillovers on productivity is dependent on the internal R&D and firms' own knowledge to internalize foreign know-how and knowledge (Buckley et al., 2002) and reduce the technological gap, meaning that a domestic firm's capacity to absorb foreign technology is correlated to its capacity to learn from foreign firms (Wei and Liu, 2006). To further strength this absorption relation, the diversity of FDI of the country of origin positively influences local productivity thus amplifying the scope of knowledge from which a firm can potentially learn, better so if these inflows of knowledge come from the OCDE countries (Zhang, Li and Zhou, 2010).

However, these positive repercussions of FDI inflows on the economic growth of host countries are extremely dependent on the existence of internal favourable circumstances and capabilities (Hermes and Lensink, 2003; Batten and Vo, 2009; Kummer-Noormamode, 2015). These latter are even more relevant for less developed countries because of their precarious social and economic situation (Nunnenkamp and Spatz, 2003; Azam and Ahmed, 2015). Indeed, the positive effect of FDI inflows on economic growth is very heterogeneous among developing countries (Alguacil, Cuadros, and Orts, 2011) and highly correlated with the stock of human capital (Borensztein et al., 1998; Xu, 2000; Li and Liu, 2005; Batten and Vo, 2009). Moreover, Borensztein et al. (1998) found a positive relation between FDI and the level of educational attainment. The creation of a domestic threshold of human capital is a vital condition for a country's absorptive capacity of FDI spillovers by contributing to reduce the 'knowledge gap' between the recipient developing country and the developed world (OCDE, 2002).

Taking into account the above arguments, we conjecture that:

H2: EEs that receive higher inflows of FDI tend to present higher growth rates.

H2a: The higher the EEs' human capital stock, the stronger the impact of FDI on EEs' economic growth.

H2b: The higher the EEs' R&D intensity, the stronger the impact of FDI on EEs' economic growth.

Even though inflows of FDI do have a positive impact on productivity growth, empirical statistical research concerning less developed countries (e.g., Krammer, 2010; Glas et al., 2015) demonstrate that imports of capital goods yield a statistically more significant effect on economic growth of less technological developed countries than inflows of FDI. The findings by Neelankavil, Stevans, and Roman Jr. (2012), focusing on 37 developing countries across Africa, Asia, and Latin America, also attribute lower importance to the impact of FDI inflows on economic growth in less developed economies. According to the authors, although inflows of FDI promote real GDP growth, this only holds in the short-run; in other words, FDI inflows are not capable of explaining real GDP growth in the long-run. Over the long-run, and according to Neelankavil et al. (2012), country's related variables such as openness to trade, human capital, and fiscal and monetary policies, might have a greater impact on the economic growth of developing countries. The effect of FDI on economic growth on least developed countries is dependent of the achievement of a degree of development in education, technology, infrastructure and health (OCDE, 2002).

In short, we conjecture that:

H3: The impact of capital goods from technological advanced countries on EEs' economic growth is higher than that of FDI.

2.3. Human capital, R&D and countries' absorptive capacity

Although both trade (Krammer, 2010; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014) and FDI (Krammer, 2010; Azam and Ahmed, 2015; Su and Liu, 2016) can promote economic and productivity growth through technological spillovers, their effects are heavily influenced by the internal capability-building factors that determine a country's 'absorptive capacity' of foreign frontier technology.

Countries' absorptive capacity usually encompasses two main dimensions: human capital and R&D investments (Wang, 2007; Krammer, 2010). This capacity can be described as a recipient country's ability to identify and assimilate foreign frontier technology and it is likely to impact positively and significantly on total factor productivity (Nelson and Phelps, 1966; Abramovitz, 1986; Glas et al., 2015).

Due to the complexity of its dimensions, human capital can be decomposed in many different variables, mainly related to education, health (e.g. life expectancy, fertility rates or infant mortality rate), and 'social capital' (Barro and Lee, 1997; Barro and Lee, 2000; Barro, 2013). Human capital can be more accurate measured as a stock variable which takes in account the labours force's education (Wößmann, 2003; Teixeira and Fortuna, 2010). However, education (Barro and Lee, 1993; Barro and Lee, 2000) is a broad concept and accommodates several variables related with school enrolment, adult literacy rates, and educational attainment, being the latter often considered a *proxy* for the level of skill possessed by a given set of the population (e.g., labour force or individuals aged twenty-five and over). Education tends to accelerate technology absorption (Nelson and Phelps, 1966) and through its positive impacts on total productivity growth facilitates the international technological catch-up process (Benhabib and Spiegel, 1994).

Human capital theory, developed by Schultz (1961) and Becker (1962), sustain the relation between human capital and economic performance. Schultz (1961) introduces the human resources of an economy as a form of capital, recipient of knowledge and skill acquired through investments in education which contribute to the productive superiority of more advanced countries (Becker, 1962). An economy capable of investing in human capital education can build a faster economic growth and escape from the poverty gap (Schultz, 1961). So, according to Temple and Voth (1998), human capital accumulation sets the pace for the industrialization process of countries by lowering the cost of adoption of foreign technologies thus facilitating the technology diffusion process, specially, when accompanied by equipment investment. Empirical studies, applied to both developed and developing countries (see Table 1) consistently find that human capital has a significant positive direct impact on productivity and economic growth, thus confirming the theoretical framework behind human capital. Thus, we hypothesised that:

H4: EEs highly endowed with human capital tend to grow faster.

Table 1: The impact of absorptive capacity (AC) and technology diffusion channels on a country's economic growth

Authors (year)	Countries analysed	Period analysed	Dependent variable	Core independent variable - absorptive capacity	Other independent variable	Empirical results
Borensztein et al. (1998)	69 developing countries	1970-1989	Real GDP *per capita*	Educational attainment FDI inflows as a share of GDP	GDP; Government consumption to GDP; Black market premium; Political Instability; Political rights; Financial development; Inflation rate; Quality of institutions.	FDI (interaction w/ human capital) *** FDI: Negative impact
Carkovic and Levine (2002)	71 countries	1960-1972	Real GDP *per capita*	FDI inflows as a share of GDP	Initial income per capita; Inflation; Government size; Openness to trade; Black market Premium; Private Credit.	No impact
Li and Liu (2005)	84 countries	1970-1999	Real GDP *per capita*	Educational attainment FDI inflows as a share of GDP	Gross domestic investment to GDP Population growth Policy variables Technology gap Telephone lines	FDI*** FDI (interaction w/ human capital) ** FDI (interaction w/ Technology gap) ** Human capital ***
Baharumshah and Almasaied (2009)	Malaysia	1974-2004	Real GDP per capita	Educational attainment FDI	Exports Domestic investment Initial income Financial intermediation	FDI** Human capital** FDI (interaction w/ human capital) **
Su and Liu (2016)	China (230 largest cities)	1991-2010	Real GDP *per capita*	Educational Attainment Foreign direct investment as a share of GDP Stock of foreign direct investment	Real GDP *per capita* Population growth rate Fixed capital investment as a share of GDP	FDI (interaction w/ human capital) *** FDI*** Human capital**
Wang (2007)	40 countries	1976 -1998	Total factor productivity (TFP)	Educational Attainment Trade-related foreign R&D stock		Human capital*** Trade-related foreign R&D***
Krammer (2010)	47 countries (27 transition, 20 developed countries)	1990- 2006	Total factor productivity (TFP)	Educational Attainment Tertiary enrollment Domestic R&D capital stock Trade and FDI spillovers	Investment and governments' shares of GDP	Human capital *** R&D *** International trade*** FDI ***
Teixeira and Fortuna (2010)	Portugal	1960-2001	Total factor productivity (TFP)	Educational Attainment Domestic R&D capital stock FDI inflows as a share of GDP International Trade (imports of machinery, licenses and royalties acquired to foreign) as a share of GDP		Human capital ** R&D*** Human capital (through imports of licenses and royalties) *** R&D (through imports of machinery) *** Human capital (through inward FDI) *
Cuadros and Alguacil (2014)	28 developing countries	1999–2009	Total factor productivity (TFP)	FDI (total and in different sectors) Trade (imports of capital goods)	Human Development Index World Bank's governance indicators	Trade** FDI***
Glas et al. (2015)	Brazil, Russia, India, China	1995–2009	Total factor productivity (TFP)	Educational Attainment Domestic R&D capital stock Imports of capital goods FDI inflows as a share of GDP	Domestic investment	FDI (interaction w/AC) *** Trade (interaction w/ AC) ** Trade*** FDI: Negative impact
Banerjee and Roy (2014)	India	1950-2010	Total factor productivity (TFP); Real GDP *per capita*	Educational Attainment R&D expenditure stock International Trade (imports of machinery and transport equipment, non-resident patent applications)	Financial deepening Share of non-food credit to GDP	Human capital *** Trade*** R&D *** Trade (interaction w/ human capital)*** Trade (interaction w/ R&D) ***

Notes: *** (**)[*] Significant at 1% (5%) [10%] level.
Source: Own elaboration

Research and development (R&D) is often the bases for innovation and builds knowledge stocks, proving to be crucial for technological progress and productivity growth (Teixeira, 2007; Sun, Wang, and Li, 2016). Domestic investments on R&D capital stocks enhance a country's capacity to absorb foreign R&D spillovers (Coe, Helpman, and Hoffmaister, 2008) and are often measured by the expenditures in R&D (Coe et al., 2008; Krammer, 2010; Teixeira and Fortuna, 2010), resultant of private (business-level) and public investments. Fagerberg (1987) defines R&D as a 'technology input' measure from which results the country's capabilities to imitate foreign imported technology.

The endogenous growth theory (see Aghion and Howitt, 1998) provides a neo-schumpeterian approach on technology progress and long-run economic growth based on business firm's investments in R&D. Accordingly, technological progress is a result of endless innovation processes through competition that creates R&D capital stock which foster economic growth (Aghion and Howitt, 1998).

Coe and Helpman's (1993) empirical evidence corroborate the endogenous theory in which domestic and foreign R&D capital stocks positively impact a country's total factor productivity. Indeed, developing countries can benefit from R&D spillovers from industrialised countries, thus boosting their output growth (Coe et al., 1997).

We therefore conjecture that:

H5: EEs that are highly intensive in R&D tend to grow faster.

Country's 'absorptive capacity' is a country's platform of assimilation of foreign technologies (see Nelson and Phelps, 1966) that promote the technological catching-up process, which is vital to less developed countries (Abramovitz, 1986). This ability to internalize, absorb and utilize foreign technological knowledge equips a country with the capacity to create new technologies and increase their productivity efficiency, which can potentially generate economic growth and drive the less developed country's convergence process forward (Abramovitz, 1986; Elmawazini, 2014).

Extant empirical evidence has suggested that the internal investment in capacity-building activities, mainly in human capital and R&D, is necessary to absorb embodied and disembodied foreign technology, because it improves a country's capacity to identify and adopt new products, processes, knowledge, and organizational competences (see

Benhabib and Spiegel, 1994; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014). In particular, empirical studies have demonstrated (see Table 1) that the interaction of domestic capability-building variables (human capital and R&D) with technology diffusion channels (trade and FDI) impact positively and significantly on countries' economic growth. Available literature for developing countries, emerging economies and countries in transition emphasises the importance of importing capital goods (e.g. Cuadros and Alguacil, 2014; Banerjee and Roy, 2014; Glas et al., 2015) and receiving foreign investment inflows (Nair-Reichert and Weinhold, 2001; Buckley et al., 2002; Glas et al., 2015; Su and Liu, 2016) for economic growth.

Summing up, a certain threshold of human capital and/or internal R&D is necessary to absorb international frontier technological spillovers, namely when interacted with trade (e.g. Wang, 2007; Krammer, 2010; Banerjee and Roy, 2014; Glas et al., 2015) or FDI (Krammer, 2010; Teixeira and Fortuna, 2010, Glas et al., 2015; Su and Liu, 2016), in order to promote economic growth (Xu, 2000; Soukiazis and Antunes, 2012). Considering the above, we hypothesise that for EEs:

H6 (=H1a/H2a): The impact of capital goods from technological advanced countries /FDI on economic growth is stronger the higher the human capital stock.

H7 (=H1b/H2b): The impact of capital goods from technological advanced countries /FDI on economic growth is stronger the higher the internal R&D intensity.

2.4. Other explanatory variables

A country's economic growth might occur through four main channels: FDI, trade, human capital and R&D. Other variables, however, are likely to impact on countries' economic growth, and therefore a study on the economic growth of EEs should control for such variables.

Following the relevant literature in the area, we can establish that countries' economic growth can be positively influenced by the quality of political and institutional environment, macroeconomic stability, and openness to trade (see Asiedu, 2002; Hermes and Lensink, 2003; Li and Liu, 2005; Batten and Vo, 2009; Kummer-Noormamode, 2015). Some empirical studies (e.g., Hermes and Lensink, 2003; Alfaro, Chanda, Kalemli-Ozcan and Sayek, 2004; Iamsiraroj and Ulubaşoğlu, 2015) have pointed out the importance of developing internal financial markets to maximize benefits from FDI and materialize those into economic growth. Additionally, some previous empirical studies found that economic growth is inversely related to government expenditure (Landau, 1983; Barro, 1991; Barro and Lee, 1994), inflation (Fischer, 1993; Barro, 1995) - that can be manifested through the reduction of productivity growth (Fischer, 1993) and the reduction of the propensity to invest (Barro, 1995) -, government-induced market distortions (Barro, 1991; Barro and Lee, 1994), and political instability (Barro, 1991; Barro and Lee, 1994). Population growth is also often considered an important variable to explain economic growth (Li and Liu, 2005; Moral-Benito, 2012; Su and Liu, 2016).

3. Methodology

3.1. Model specification

The existing literature relevant to our analyses (see Table 2) has resorted to different estimation techniques. Specifically, several empirical studies use panel data models, repeated observations of the same units over time, to estimate the relation between technological transfer channels and economic growth for a large panel of countries over extensive periods of times with the objective of correcting for continuously evolving country's heterogeneous technology, production, and socioeconomic characteristics (Verbeek, 2004; Li and Liu, 2005).

Table 2: Synthesis of relevant studies according to their method of analysis

Authors (year)	Countries analysed	Period analysed	Estimation Methods
Borensztein et al. (1998)	69 developing countries	1970-1989	Panel data
Li and Liu (2005)	84 countries	1970-1999	Panel data
Wang (2007)	40 countries (25 developing countries and 15 industrialized OECD trading partners)	1976 -1998	Panel data
Glas et al. (2015)	Brazil, Russia, India, China	1995–2009	Panel data
Su and Liu (2016)	China (230 largest cities)	1991-2010	Panel data
Carkovic and Levine (2002)	71 countries	1960-1972	Ordinary least squares (OLS) and Dynamic panel data
Cuadros and Alguacil (2014)	28 developing countries	1999–2009	Dynamic panel data
Baharumshah and Almasaied (2009)	Malaysia	1974-2004	Co-integration
Teixeira and Fortuna (2010)	Portugal	1960-2001	Co-integration
Banerjee and Roy (2014)	India	1950-2010	Co-integration
Krammer (2010)	47 countries (27 transition, 20 developed countries)	1990- 2006	Panel unit root and Panel Co-integration

Source: Own elaboration

Thus, in accordance to the literature, the present dissertation employs a panel data econometric model to a set of 39 EEs[1], classified using Saccone's (2017) recent categorization, over the period from 1961 to 2015. In contrast with Saccone (2017) we considered Serbia and Montenegro as separated countries benefiting from data

[1] Albania, Angola, Armenia, Azerbaijan, Bangladesh, Belarus, Bulgaria, Cambodia, Chile, China, Colombia, Dominican Republic, Ethiopia, Ghana, India, Indonesia, Kazakhstan, Latvia, Lithuania, Morocco, Mozambique, Myanmar, Nigeria, Peru, Philippines, Poland. Romania, Serbia, Montenegro, Sri Lanka, Tanzania, Thailand, Turkey, Turkmenistan, Uganda, Uruguay, Uzbekistan, Vietnam, Zambia.

availability. Unlike the cross-section and time series analyses, panel data models have the advantage of explaining individual unit's different behaviors and its changes at different periods in time, thus taking into account the heterogeneity between countries over the relevant time span (Verbeek, 2004; Greene, 2011).

In order to assess the impact of technology transference channels (imports of capital goods, FDI, human capital, and R&D) on economic growth of EEs, during the proposed time frame (1961-2015), we empirically test the hypotheses mentioned in Section 2, using the following multiple linear specification:

$$Y_{it} = \beta_1 + \beta_2 ImpK_{it} + \beta_3 FDI_{it} + \beta_4 HC_{it} + \beta_5 R\&D_{it} +$$

$$+ \underbrace{\beta_6 (HC * ImpK)_{it} + \beta_7 (R\&D * ImpK)_{it} + \beta_8 (HC * FDI)_{it} + \beta_9 (R\&D * FDI)_{it}}_{Absorptive\ Capability} +$$

$$+ \beta_{10} C_{it} + \mu_{it},$$

Where *i* represents the country, *t* the time period, and:

Y country's economic growth;

ImpK imports of capital goods (in % GDP);

FDI inward flows of foreign direct investment (in % GDP);

HC human capital stock;

R&D domestic expenditure in R&D (in % GDP);

HC* ImpK interaction between human capital and the imports of capital goods;

R&D* ImpK interaction between R&D and the imports of capital goods;

HC*FDI interaction between human capital and foreign direct investment;

R&D*FDI interaction between R&D and foreign direct investment;

C vector of control variables (e.g., government expenditure, political rights, inflation, population growth, and trade openness).

3.2. Data and variable description

The dependent variable, $\boldsymbol{Y_{it}}$, is an indicator of country *i*'s economic growth, which results, among other, from the technological transfer process. Existing empirical studies (see Table 1) measure economic growth mainly using two *proxies*: annual average growth rate of real Gross Domestic Product (GDP) *per capita* or Total Factor Productivity (TFP). Given that for some EEs data on TFP is not available, we estimated the econometric specification above using both variables, the annual average growth rate of real GDP *per capita* and TFP growth. For this end, we retrieved the annual average growth rate of real GDP *per capita* data from the World Bank, database which reports values at constant local currency. To measure the TFP annual growth rate, we extracted data from the Penn World Tables (version 9.0) that reports TFP levels at constant 2011 prices against the reference year (2011) and then we proceeded to calculate the annual growth rates.

The independent variable imports of capital goods *(ImpK)* is *proxied* by the share of capital goods imports at current PPPs, extracted from the Penn World Tables (version 9.0). It stands as an indicator of embodied technology diffusion (see Teixeira and Fortuna, 2010; Banerjee and Roy, 2014), and is expected to positively affect economic growth and total factor productivity growth (Lawrence and Weinstein, 1999).

Regarding the inflows of FDI to host emerging economies, we measure these inflows as a ratio, that is, in percentage of the GDP (e.g. Borensztein et al., 1998; Hermes and Lensink, 2003; Alfaro et al., 2004; Li and Liu, 2005). This variable focuses exclusively on the inward flows of FDI received by EEs, which presumably will benefit from the knowledge and spillover effects carried by foreign direct investment vital to close the technological gap (Borensztein et al., 1998). To obtain values for this variable we resorted to the Foreign Direct Investment: inward flows (percentage of Gross Domestic Product) taken from the UNCTAD database. Data is only available for the 1970-2015-time span.

The measurement of the explanatory variable human capital (*HC),* as noted by Wößmann (2003), is often poorly *proxied* in empirical growth research. Among its set of measurements/*proxies*, we can include the adult literacy rates, school enrolment ratios, and educational attainment of the labour force. The first two measurements present clear flaws as the literacy rates neglect the qualifications obtained beyond the basic levels of education and the school enrolment ratios corresponds to a flow variable that include under-age individuals that are not yet part of a country's labour force (Wößmann, 2003; Teixeira and Fortuna, 2010). Educational attainment is a stock variable that considers the total amount of formal education received by the labour force taking into account the latter's degree of qualification (Wößmann, 2003). It thus provides the best available information on a country's level of human capital stock (Teixeira and Fortuna, 2010).

Accordingly, the present dissertation uses the average years of schooling of the working-age population as a *proxy* for the human capital, in line with other empirical studies (e.g., Benhabib and Spiegel, 1994; Barro, 1997; Krueger and Lindahl, 2001; Teixeira and Fortuna, 2010). Specifically, based on the referenced literature, we use the average years of schooling of the population aged 25 years old and over from the human capital database constructed by Barro and Lee (2010). This database comprises worldwide data of educational attainment for 146 countries in 5-year intervals from 1950 to 2010.

As mentioned by Griffith, Redding, and Reenen (2003), countries that engage in R&D can increase their ability to understand and assimilate foreign discoveries which facilitates technology transfers. Therefore, cumulative indigenous R&D efforts play an important role in boosting an economy's productivity and growth (Coe and Helpman, 1993; Teixeira, 2007). Fagerberg (1987) measures the stock of technological knowledge by dividing technological activities into two types: technological inputs (e.g. R&D expenditure, scientists and engineer employment), and technological output (e.g. patents). In the present dissertation, we favour technological inputs, most notably, domestic expenditures on R&D to GDP ratio from the World Bank database. Data is only available for the 1996-2015 period.

As for the control variables (*C*), government expenditure is represented by the ratio of government consumption to GDP (e.g. Landau, 1983; Barro and Lee, 1994, Borensztein et al., 1998; Alfaro et al., 2004), more specifically the share of government consumption at current PPPs in the Output-side real GDP at current PPPs, whose data come from the Penn World Table (version 9.0) database. The inflation rate, extracted from the World Bank database, measures the annual growth rate of the GDP implicit deflator. The population growth data was also extracted from the World Bank database. To measure political stability, we resorted to the political rights (*PR*) variable from the Freedom House database for the 1996-2015 and 2005-2015 periods, estimated in a scale of 1 to 7 (1=Most Free, 7=Least Free). Finally, in accordance with the importance of trade liberalization approached in Section 2.1, we introduced, as a control variable, a trade openness indicator that measures the sum of exports and imports of goods and services, as a share of gross domestic product, whose data was extracted from the World Bank database.

3.3. Variables Description

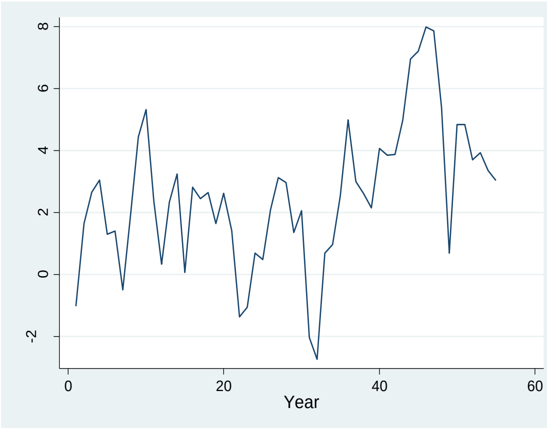
The dependent variable *GDPpcg*, measuring annual average growth rate of real GDP *per capita*, represents the heterogeneous economic growth differences among the diversified group of chosen emergent countries. The mean value of this variable indicates that the economic growth of the analysed countries is 2.9% from 1961 to 2015, with a 5.6 standard deviation, as a result of a wide range of economic growth, that variates from a minimum negative growth rate of 40.7% (Armenia, 1992) to a maximum positive rate of 33.0% (Azerbaijan, 2006) (see Table 3).

The other independent variable, Total Factor Productivity annual growth rate (*TFPg*) has a considerable lower number of observations (N = 1071), specially compared to the real GDP *per capita* growth rate (N = 1549). As for its mean, TFPg has a mean of 0.7% with a 5.1 standard deviation and minimum value of -39.5% (Armenia, 1992) and a maximum value of 27.7% (Morocco, 1961) (see Figure 2).

Table 3: Variables description for the extended model (1961-2015)

Variables			N	Mean	Percentil 50	Standard deviation	Min	Max
Dependent variables	*GDPpcg*	Growth rate of real gross domestic product *per capita* (in %)	1549	2.902	3.334	5.598	-40.747	33.030
	TFPg	Growth rate of Total Factor Productivity (in %)	1071	0.726	1.097	5.110	-39.473	27.653
Core variables	*ImpK*	Imports of capital goods at current PPPs (% of GDP)	1761	2.936	2.060	2.681	0.005	21.345
	FDI	Foreign Direct Investment: inward flows (% of GDP)	1441	2.278	1.120	3.481	-5.499	38.549
	HC	Average years of schooling of the adult population	1550	5.365	5.170	2.859	0.470	11.740
	R&D	Domestic expenditures on R&D (% of GDP)	383	0.467	0.391	0.328	0.005	2.046
Control variables	*G*	Government consumption at current PPPs (% of GDP)	1761	20.484	17.416	11.882	1.663	74.471
	π	Inflation, GDP deflator (in %)	1545	54.233	8.645	300.033	-20.860	6261.2
	Popg	Population growth (in %)	2115	1.629	1.732	1.204	-3.373	4.189
	Trade openness	Trade (% of GDP)	1486	58.793	51.601	33.425	0.167	178.994
	PR	Politic rights (1=Most Free, 7=Least Free)	1486	4.454	5.000	2.071	1.000	7.000

Source: Own elaboration



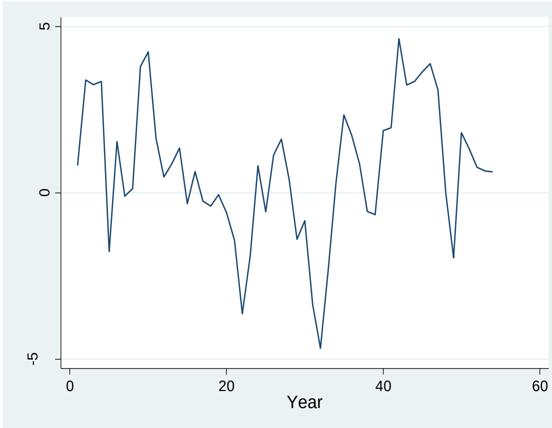


Figure 1: **Average growth rate of GDP *per capita* (1961-2015)**

Figure 2: **Average growth rate of TFP (1961-2015)**

Source: Own computation

Concerning the independent variable trade of capital goods, *proxied* by share of capital goods imports at current PPPs (*ImpK*), we found a 2.9% average share of imports on GDP, with a 2.7 standard deviation, as a result of a set of values that variates from 0.005% (Cambodia, 1976) to 21.3% (Mozambique, 2013).

Another independent variable is the inward flows of foreign direct investment as a percentage of the GDP, whose mean is 2.3%, and has a standard deviation of 3.5, resultant of a variation between the minimum value of -5.5% (Angola, 2012), and the maximum value of 38.5% (Mozambique, 2013). The negative values of this this indicator derive from the methodology utilized by the UNCTAD database that calculates FDI flows in net bases as a result of capital transactions’ credits less debits made between direct investors and their foreign investors which explains the negative results as a result of disinvestment or reverse investment.

As depicted in Figures 3 and 4, there is a clear upward trend in the capital goods imports and FDI inflows (in percentage of the GDP) of emergent countries over the last three decades, which reflect an increasing importance of the technology transfer channels in these economies.

Figure 3: Average capital imports share in GDP (1961-2015)

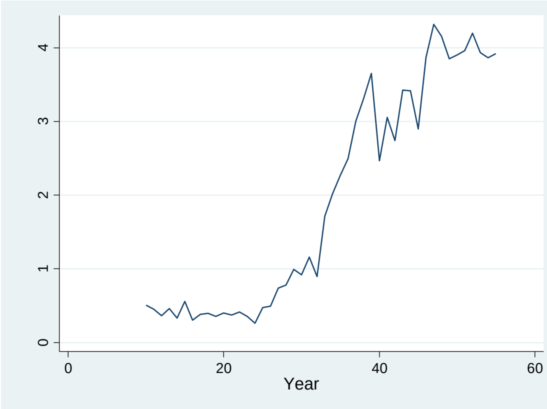


Figure 4: Average inward FDI flows in GDP (1970-2015)

Source: Own computation

Data for human capital reports that individuals aged 25 and plus years of age possess an average of 5.4 years of formal schooling, with a 2.9 standard deviation. Thus, the adult population of EEs presents relatively low average years of schooling, ranging between a minimum of 0.47 years (Morocco, 1961-1965) and 11.7 years (Kazakhstan, 2001-2005).

Regarding Research and Development (R&D) expenditures as a percentage of GDP, data available is scarce (N= 383), covering a limited time span (1996-2013) (see Figure 6). R&D intensity presents a low average of 0.47% and a standard deviation of 0.3.

The absorptive capacity enhancers, human capital and R&D intensity evidence a gradual increase over the period in analysis (see Figures 5 and 6).

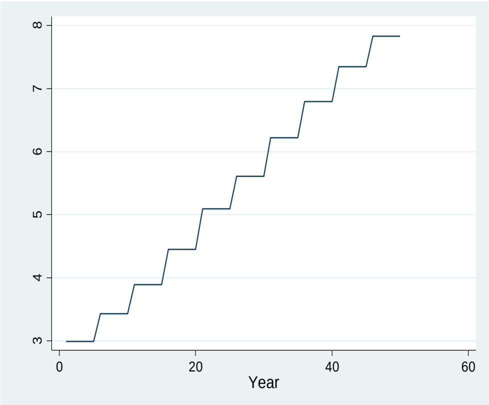


Figure 5: Average years of schooling (1961-2015)

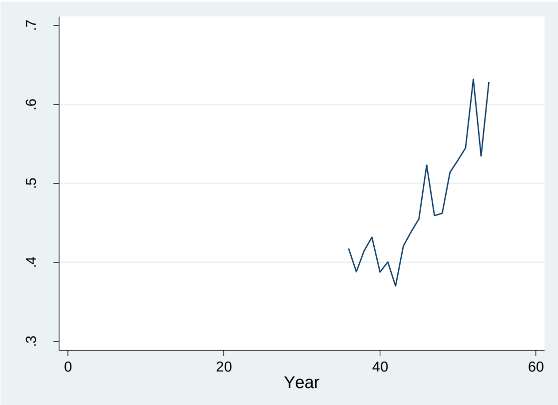


Figure 6: Average R&D intensity (1996-2015)

Source: Own computation

Regarding the control variables, inflation observes a very high mean, 54.2%. The standard deviation of this variable is also very high (300.03), compared to its mean, reflecting the existence of an astonishingly wide range of inflation rates that includes deflation (negative inflation rates) (e.g. Turkmenistan, 1990), running inflation, galloping inflation, and even hyperinflation (e.g. Peru, 1990). For the trade openness variable, on average and considering the whole period in analysis, exports and imports represent about 59% of the GDP, which reflects the relatively high importance of international trade for EEs. Finally, political rights variable indicator mean indicates that, on average EEs tend to moderately protect most of political rights, but this protection can be flawed leading to violation of some political rights. The minimum for this variable (1) represents the best performer country (e.g. Poland, 2015) whereas the maximum (7) evidence the worst performer (e.g. China, 2015).

Concerning the analyses of our *core* variables by level of income, we observe (Figure 7) that the share of capital goods imports at current PPPs (% of GDP) has a more important role in the low and lower middle income countries when compared to the upper middle income countries, for the period 1961-1989. However, this situation was reversed in the following period, 1990-2015, and the upper middle income countries became the income group in which imports of capital goods at current PPPs presented a larger proportion of the GDP.

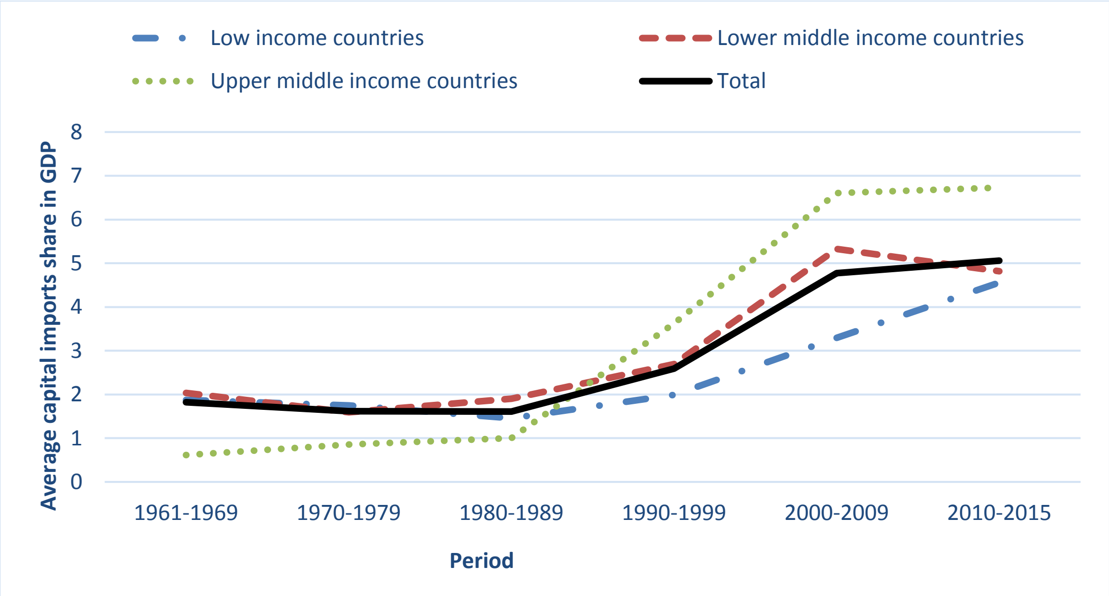


Figure 7: Average capital imports share in GDP (1961-2015) by level of income

Source: Own computation

These results coincide with the global results of the share of capital goods imports at current PPPs (% of GDP) for all group of incomes that drops between 1961 to 1989 and constantly increases in the 1990-2015 period (1961-1969: 1.82%, 1970-1979: 1.62%, 1980-1989: 1.61%, 1990-1999: 2.59%, 2000-2009: 4.77%, 2010-2015: 5.06%).

For the inward flows of foreign direct investment (in % of GDP) variable, data shows that the weight of FDI inflows in GDP has been increasing throughout all the analysed periods (1970-1979: 0.37%, 1980-1989: 0.50%, 1990-1999: 2.21%, 2000-2009: 3.42%, 2010-2015: 3.96%). Furthermore, it is also interesting to observe that FDI inflows (% of GDP) are larger in low income countries and lower middle income countries than in upper middle income countries in the 1990-2015 period - see Figure 8. The dynamics of this variable in low income countries (1961-1969: 0.32%; 2010-2015: 5.59%) and lower middle income countries (1961-1969: 0.40%; 2010-2015: 3.49%) is also quite remarkable.

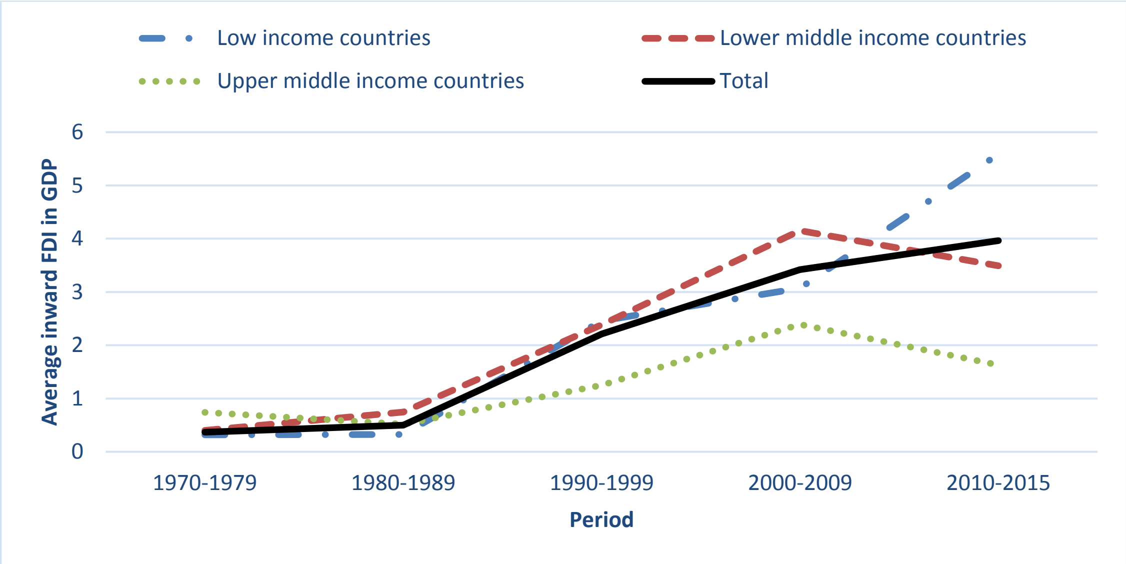


Figure 8: Average inward FDI flows in GDP (1970-2015) by level of income

Source: Own computation

Regarding the human capital, data by level of income shows a clear increase of the average years of schooling of the adult population in all groups of incomes throughout the entire period (1961-2015) – see Figure 9. The low income countries possess the lowest educational attainment throughout the entire period (1961-1969: 1.8 years; 2010-2015: 5.8 years), and on the other side, the upper middle income countries have the highest from the beginning (1961-1969: 5.1 years) to the end (2010-2015: 10.3 years).

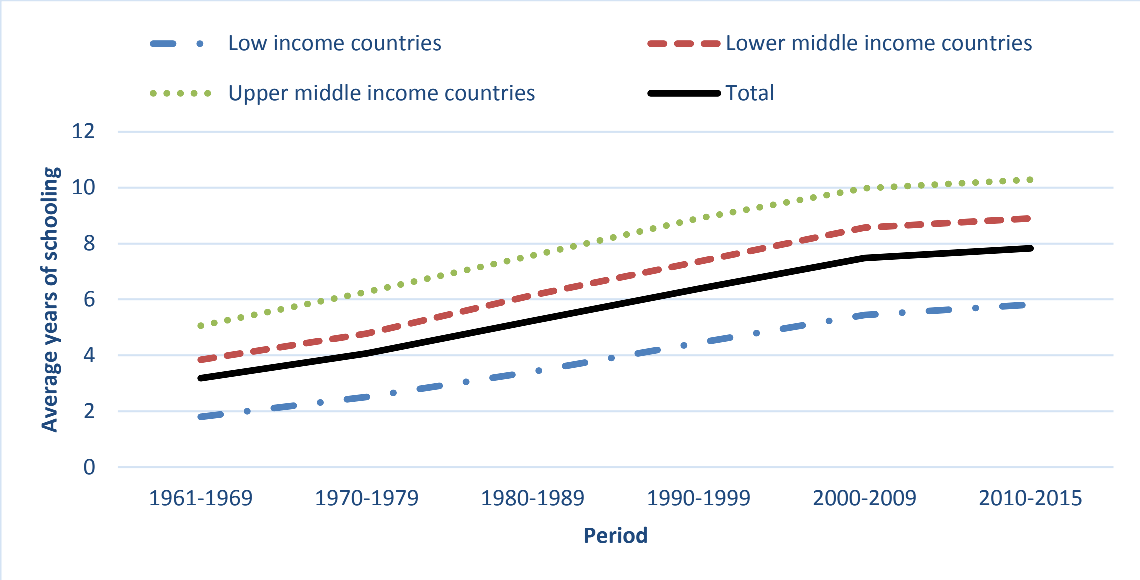


Figure 9: Average years of schooling (1961-2015) by level of income

Source: Own computation

Data for Research and Development (R&D) expenditures as a percentage of GDP, although with limited time availability (1996-2013), indicates that in the upper middle income countries R&D presents a larger share of GDP than in the other income group countries, despite that difference have been shortened in the 2010-2015 period to the point in which R&D expenditures represent a larger share of the GDP in low income countries (0.53%) than in the lower middle income countries (0.42%) – see Figure 10.

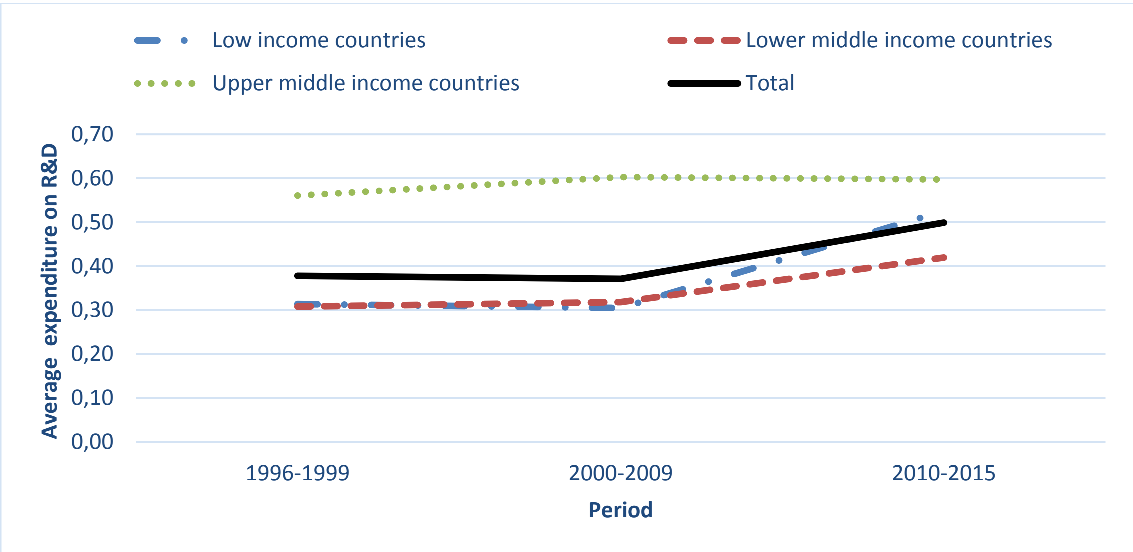


Figure 10: Average R&D intensity (1996-2015) by level of income

Source: Own computation

Moving on to the analyses by world regions and beginning with the share of capital goods imports at current PPPs (% of GDP), we can observe (Figure 11) that East Asia & Pacific (1961-1969: 1.63%; 2010-2015: 5.89%), Latin America & Caribbean (1961-1969: 1.96%; 2010-2015: 4.76%),Sub-Saharan Africa (1961-1969: 2.75%; 2010-2015: 5.20%), Europe & Central Asia (1961-1969: 0.36%, 2010-2015: 5.36%) and the Middle East & North Africa (1961-1969: 1.90%, 2010-2015: 4.75%) had consistent and remarkable increases throughout the entire period, mainly during the 1980-2009 time span, whilst the South Asia region had a rather shy growth trajectory (1961-1969: 0.68%, 2010-2015: 1.83%).

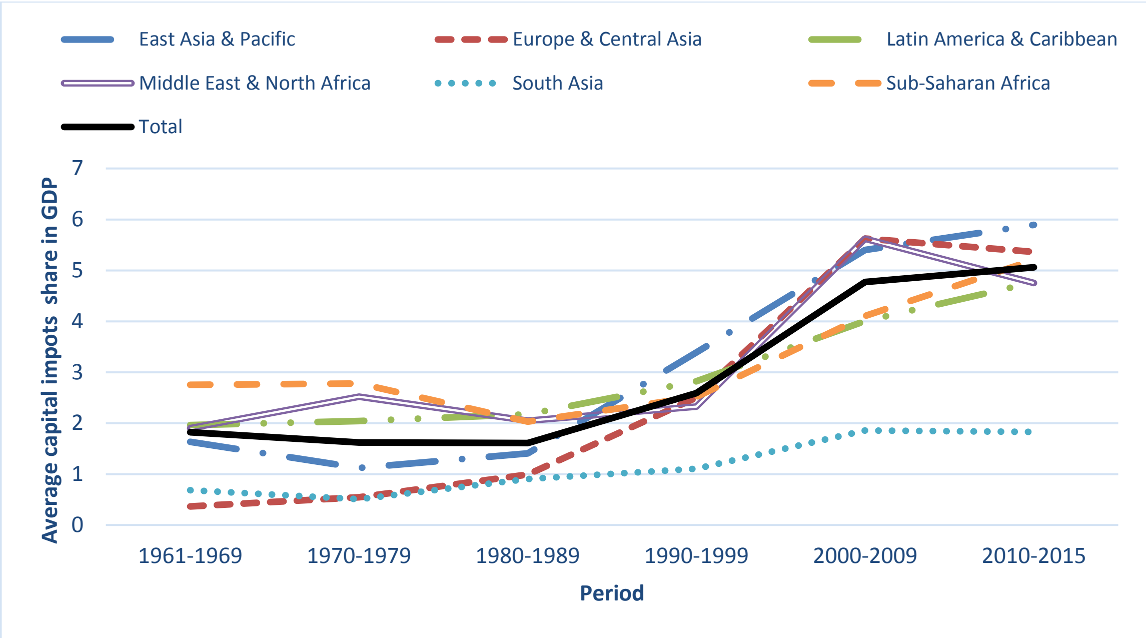


Figure 11: Average capital imports share in GDP (1961-2015) by world region

Source: Own computation

Concerning the inward foreign direct investment flows (% of GDP), there is in total terms (all regions included), during the entire period (1970-2015), a clear growth of the weight of foreign direct investment flows as a share of GDP (1970-1979: 0.37%; 1980-1989: 0.50%; 1990-1999: 2.21%; 2000-2009: 3.42%; 2010-2015: 3.96%) – see Figure 12. Moreover, inward foreign direct investment flows as a share of GDP has an outstanding increase on the Sub-Saharan Africa region (1970-1979: 0.36%; 1980-1989: 0.57%; 1990-1999: 2.44%; 2000-2009: 3.90%; 2010-2015: 6.70%).

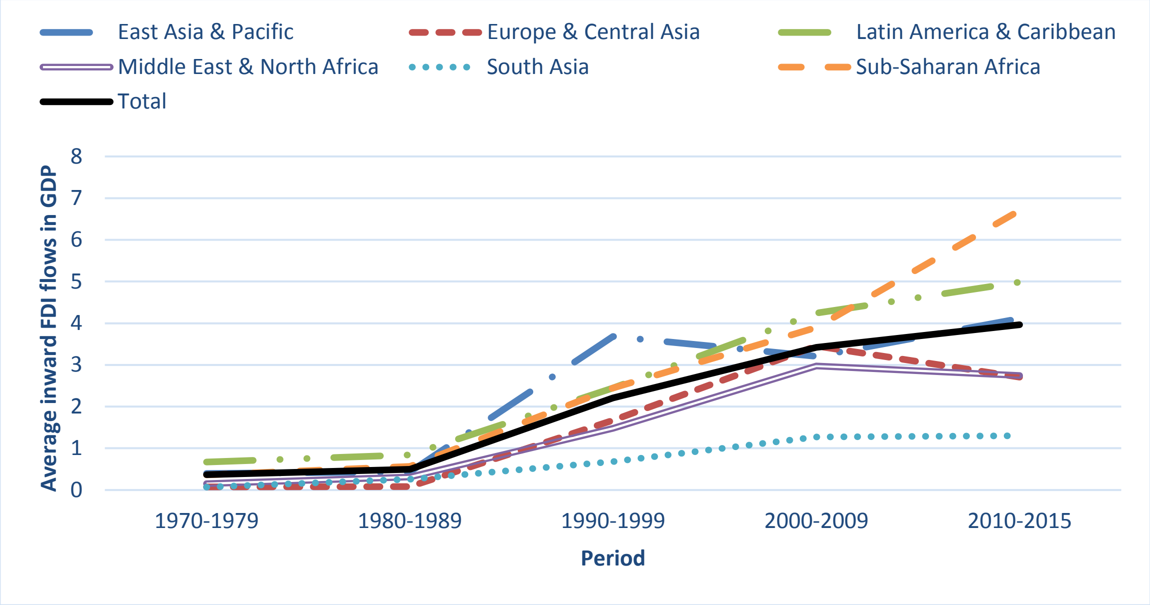


Figure 12: Average inward FDI flows in GDP (1970-2015) by world region

Source: Own computation.

Data for the human capital variable highlights that the average years of schooling of the adult population has grown in all world regions throughout all the periods (1961-2015: 3.19 years; 1970-1979: 4.07 years; 1980-1989: 5.23 years; 1990-1999: 6.39 years; 2000-2009: 7.49 years; 2010-2015: 7.83 years) – see Figure 13. The most highly educated region is Europe & Central Asia (1961-1969: 4.92 years; 2010-2015: 10.49 years) and the least educated is the Middle East & North Africa (1961-1969: 0.51 years; 2010-2015: 4.24 years).

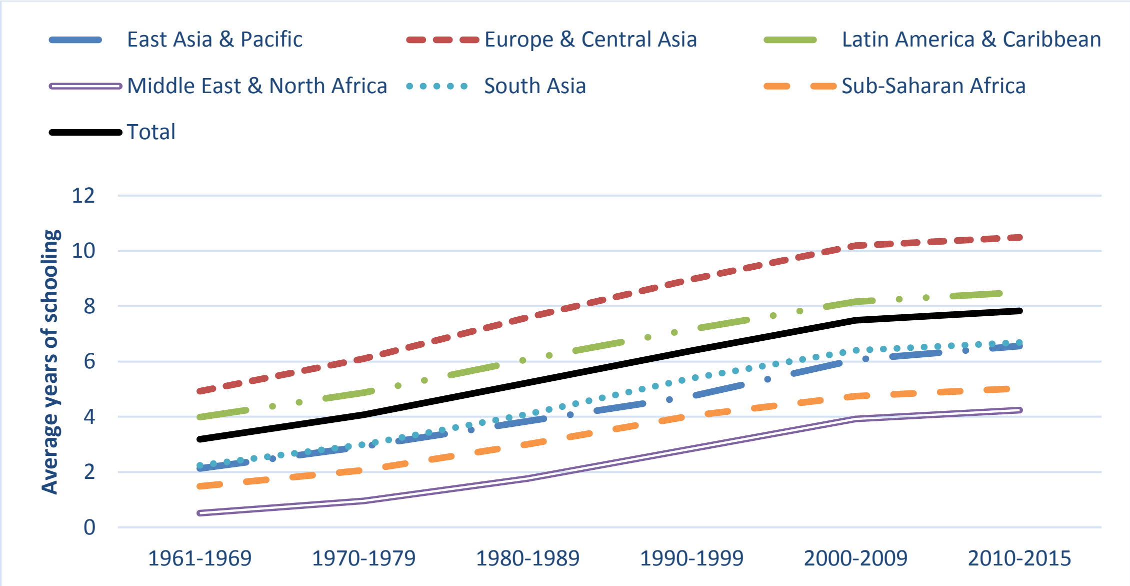


Figure 13: Average years of schooling (1961-2015) by world region

Source: Own computation

Domestic R&D expenditure (in % of GDP) registers a shy global tendency to grow across the 1996-2015 period (1996-1999: 0.38%; 2010-2015: 0.50%). Analysing by world regions, it is relevant to observe that in the 2000-2015 period, R&D domestic expenditures represent a larger share of the GDP in the Middle East & North Africa region (2000-2009: 0.62%; 2010-2015: 0.71%) than in any other region of the world – see Figure 14. Moreover, domestic expenditures on R&D (% of GDP) has increased remarkably on the Sub-Saharan Africa region (1996-1999: 0.01%; 2000-2009: 0.24%; 2010-2015: 0.43%), leavening the place of lowest spender on R&D (% of GDP) to the Latin America & Caribbean region by the end of the period (2010-2015: 0.30%).

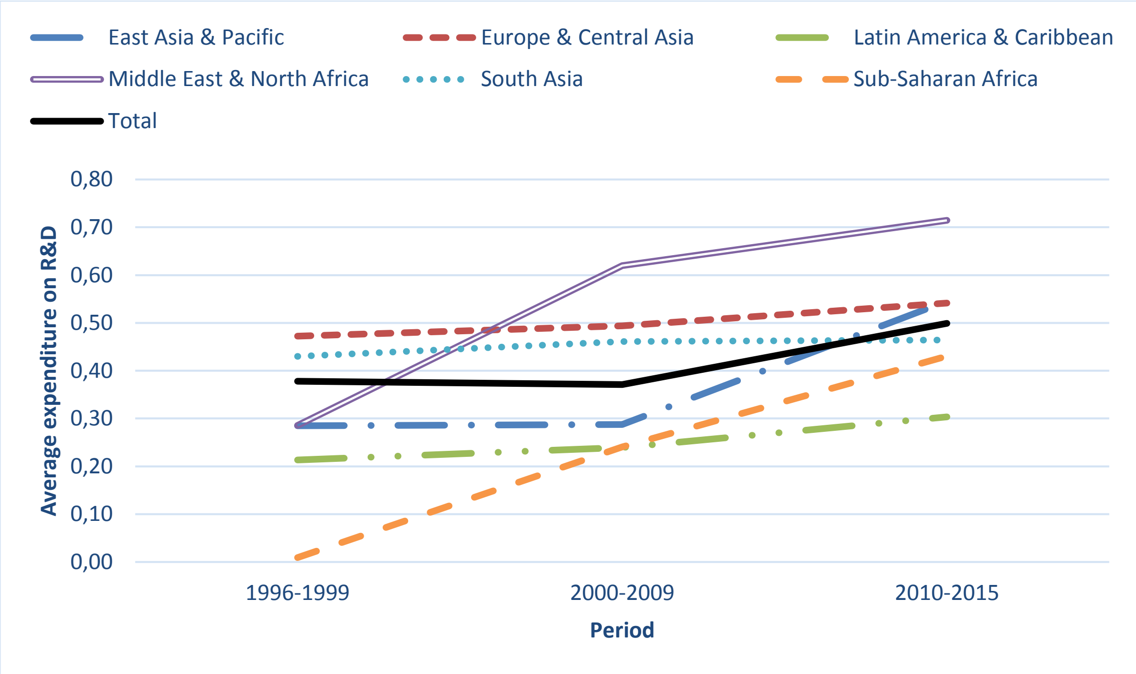


Figure 14: Average R&D intensity (1996-2015) by world region

Source: Own computation

3.4. Diagnosis tests

3.4.1. Multicollinearity

An important aspect of the growth model is the use of correlated variables, which might hamper the model from identifying the individual impact of the correlated variables leading to unreliable regression estimations due to the existence of a near perfect linear relationship between the estimated analysed variables (Verbeek, 2004).

As observed in the correlation matrix (see Table A1 in Appendix) we can conclude that there is a relatively high correlation among some variables, most notably between trade openness and imports of capital goods, population growth and human capital (average years of schooling of the adult population) and between Government expenditures and population growth.

The VIF test for collinearity provides an index measurement of how the variance of an estimated coefficient is *inflated* by the presence of multicollinearity (Gujarati, 2004; O'Brien, 2007). However, literature does not propose a clear cut threshold indicative of when multicollinearity levels have become too excessive and unacceptable (O'Brien, 2007). Some accepted thresholds include a value for the VIF as low as 4 to values as high as 10 or higher (O'Brien, 2007). The most commonly accepted rule of thumb - the rule of 10 – states that values, for this index, exciding 10 reveal the existence of an excessive collinearity (Gujarati, 2004; O'Brien, 2007).

The VIF's index values estimated for 1961-2015 period (see Table A2 in Appendix) indicate the presence of a low collinearity between explanatory models in our model. Indeed, the highest VIF is 2.58 (population growth) and the mean VIF is 1.80, which falls short from the above referenced values for the rule of thumbs. Most importantly, the VIF test was applied to all models (including the TFP models) and the obtained results were very similar to the ones we presented above (low collinearity).

3.4.2. Heteroscedasticity

Heteroscedasticity, or unequal variance (Gujarati, 2004), as referenced by Greene (2011: 297), arises in "volatile high-frequency time-series data" or in "cross-section data where the scale of the dependent variable and the explanatory power of the model tend to vary across observations", which might happen when different groups in the sample have different variances (Verbeek, 2004).

Indeed, our empirical estimations employed a panel data of 39 EEs, incorporating a vast array of countries with different economic and social realities. According to the World Bank income level classification, our panel data contains countries from three different income levels in the beginning of our analysis (1961): (i) low income, (ii) lower middle income, and (iii) upper middle income. In the final period (2015) some countries (e.g. Chile, Latvia, Lithuania, Poland, Uruguay) reached the high-income level.

These 39 countries are also scattered across six different regions (East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North, Africa, North America, South Asia, Sub-Saharan Africa), also according to World Bank classifications.

After we employed the Breusch–Pagan and White tests for Heteroscedasticity for the *baseline* model (1961-2015), we rejected the null hypothesis of homoscedasticity for the most commonly used levels of significance (e.g. 1%, 5% and 10%) (see Table A3 in Appendix). Thus, there is evidence of heteroskedasticity (Verbeek, 2004; Greene, 2011) which required correction though the estimation of robust standard errors.

4. Empirical estimations

4.1. Global results

For each proxy of economic growth - the annual average growth rate of real Gross Domestic Product *per capita* (see Table 4, Models A) and Total Factor Productivity annual growth rate (see Table 4, Models B) –, we estimate 6 models, 3 without interaction terms (Model 1-Model 3), and 3 with interaction terms (Model 4-Model 6), which permits to test the absorptive capabilities hypotheses (*H6* and *H7*). Model 1 and Model 4, are the *baseline* models, comprising the whole period in analysis (1961-2015); it thus discards R&D intensity and political rights variables as these are only available for more recent periods (respectively, 2005-2015 and 1996-2015). Model 2 and Model 5 are estimated for the period 1996-2015 – they comprise the *baseline* model plus the variable political rights. Model 3 and Model 6 add to the latter the variable R&D intensity, and covers the 10 most recent years (2005-2015).

Given the heteroscedasticity issues, the models were estimated using robust estimation of fixed effects panel data model. The option for the fixed effect instead of random effect was driven by the theory (being in most of the cases econometrically supported by the rejection of the Hausman test).[2]

For the 1961-2015 period, without the interaction terms (Model A1), the estimates indicate a highly significant effect, at a 1% significance level, of the imports of capital goods and FDI inward flows on economic growth. Additionally, the imports of capital goods have a slightly larger impact on economic growth than FDI flows: a one percent change in the imports of capital goods (FDI inflows) leads to a 0.32 (0.31) percentage point increase in economic growth.

Human capital, proxied by the average schooling of the adult population, fail to emerge statistically significant. When we include the interaction terms (Model A4), results obtained reinforce the previous evidence: the *global* marginal impact of imports of capital goods (0.3636, p-value<0.01) is higher than that of inward flows of FDI (0.2805, p-value<0.01). This impact occurs mainly in a direct fashion, with the absorptive capability estimates (interaction between human capital and trade channels) being non-significant. Such results strongly support *H1* ("*EEs that import more capital goods from*

[2] The Hausman test is described as a test for model misspecification. In panel data analysis, it helps to choose between fixed or random effects model. The null hypothesis is that the two estimation methods are adequate and that therefore they should yield similar coefficients. The alternative hypothesis is that the fixed effects estimation is adequate and the random effects estimation is not.

technological advanced countries tend to present higher growth rates") and, to some extent, *H2* ("*EEs that receive higher inflows of FDI tend to present higher growth rates*"). Additionally, the impact of imports of capital goods on economic growth of EEs tend to be higher than that of FDI inflows. This permits to corroborate *H3* ("*The impact of capital goods from technological advanced countries on EEs' economic growth is higher than that of FDI*").

Also without the interaction terms, when we introduce political rights as a control variable, which correspond to the period 1996-2015 (Model A2), results indicate a change in the importance of the *core* variables on economic growth: the positive impact of imports of capital goods continues to be significant but at a smaller significance level (5%) while FDI's impact becomes non-significant. Thus, we can corroborate *H1* and *H3* but there is no sufficient evidence to support or not support *H2*.

The introduction of the interaction terms, provides a quite distinct picture, particularly for the most recent periods. Indeed, for the whole period, 1961-2015 (Model A4), the *global* impact of the imports of capital goods (in % GDP) and the inward flows of foreign direct investment (in % GDP) are statistically significant and positive, with the former having a higher impact on EEs economic growth than the latter. Thus, for the period 1961-2015, *H1*, *H2* and *H3* are validated.

Regarding the most recent periods (1996-2015 – Model A5 -, and 2005-2015 – Model A6), there is not sufficient evidence to corroborated or not corroborate such hypotheses. Notwithstanding, in the period 1996-2015, higher FDI inflows *directly* and *indirectly* (through human capital) positively impact on EEs' economic growth. In the last ten year period (2005-2015), the *direct* impact of inward flows of foreign direct investment (in % GDP), human capital stock, and R&D domestic expenditures in R&D (in % GDP) on economic growth is significant but negative, albeit EEs that possess a higher R&D intensity managed to significantly benefit from inward flows of foreign direct investment (marginal effect estimate of 2.6940 for a p-value<0.05).

The control variables, when significant, present in general the expected signal. All the remaining factors being held constant, on average, EEs with higher public expenditures and higher inflation rates tend to growth less, whereas those more open in terms of trade and with better institutions (reflected by a lower political rights index, that is, that are better ranked in terms of political rights) grow faster.

Table 4: Determinants of economic growth, panel data fixed effects (marginal effects, robust standard errors in brackets)

		GDP *per capita* growth						TFP growth					
		Without interaction			With interaction			Without interaction			With interaction		
		1961-2015	1996-2015	2005-2015	1961-2015	1996-2015	2005-2015	1961-2015	1996-2015	2005-2015	1961-2015	1996-2015	2005-2015
		Model A1	Model A2	Model A3	Model A4	Model A5	Model A6	Model B1	Model B2	Model B3	Model B4	Model B5	Model B6
International trade's direct impact	Imports of capital goods (in % GDP)	0.3226*** (0.1079)	0.3256** (0.1583)	1.2894** (0.6343)	0.5920** (0.2791)	0.3010 (0.4344)	-2.3396 (2.0518)	0.0289 (0.1352)	-0.1404 (0.2826)	-0.1091 (0.4458)	0.0871 (0.3335)	0.2082 (0.4684)	-2.5477 (2.0946)
	Inward flows of foreign direct investment (in % GDP)	0.3137*** (0.0999)	0.1310 (0.1075)	0.1787 (0.1615)	0.0656 (0.2371)	0.4517*** (0.1644)	-1.4386** (0.7321)	0.2162** (0.1036)	0.1724 (0.1160)	-0.0627 (0.1319)	0.1926 (0.2490)	-0.6319** (0.2621)	2.4357*** 0.7028
Competencies	Human capital stock	0.0181 (0.2135)	-0.1562 (0.5941)	-0.7075 (1.3946)	0.0425 (0.2347)	-0.3641 (0.5937)	-3.5540** (1.7320)	0.1656 (0.2341)	0.2442 (0.5513)	0.5299 (1.2329)	0.1774 (0.2490)	0.1981 (0.5976)	-3.0724** (1.5150)
	R&D domestic expenditures in R&D (in % GDP)			-9.6536 (6.3540)			-22.8236** (9.8432)			-6.6443 (5.6985)			20.9012** (8.5240)
Absorptive capabilities	Interaction between human capital and the imports of capital goods ***(H6/H1a)***				-0.0380 (0.0305)	-0.0043 (0.0418)	0.2265 (0.1902)				-0.0074 (0.0390)	-0.0415 0.0512	0.1009 (0.1807)
	Interaction between R&D and the imports of capital goods ***(H7/H1b)***						1.5004 (1.3538)						1.4975 (1.2875)
	Interaction between human capital and foreign direct investment ***(H6/H2a)***				0.0358 (0.0297)	0.0819*** (0.0282)	0.0470 (0.0560)				0.0031 (0.0330)	0.0911** (0.0352)	0.0847 (0.0657)
	Interaction between R&D and foreign direct investment ***(H7/H2b)***						2.6940** (1.3350)						3.7200*** (1.4170)
Global impact	Imports of capital goods (in % GDP) ***(H1)***				0.3636*** (0.1376)	0.2698 (0.1813)	0.3440 (0.7394)				0.0405 (0.1561)	-0.1178 (0.2786)	-0.8581 (0.5682)
	Inward flows of foreign direct investment (in % GDP) ***(H2)***				0.2805*** (0.1014)	0.1463 (0.0951)	0.2809 (0.2204)				0.2119** (0.0969)	0.0842 (0.1005)	0.2828 (0.2710)
	Human capital stock ***(H4)***				-0.0030 (0.1985)	-0.0892 (0.6007)	-1.9150 (1.6674)				0.1585* (0.2348)	0.3190 (0.5528)	-2.0589 (1.3539)
	R&D domestic expenditures in R&D (in % GDP) ***(H5)***						-1.9703 (5.9661)						4.4194 (6.2198)
Control variables	Government expenditure in GDP	-0.1435** (0.0730)	-0.1617** (0.0768)	-0.9443* (0.4890)	0.1500*** (0.0749)	-0.1714** (0.0694)	-1.0492** (0.4282)	-0.1596* (0.0826)	0.2139*** (0.0774)	-1.1634** (0.5115)	-0.1608* (0.0860)	0.2144*** (0.0714)	1.2457*** (0.3947)
	Inflation	-0.0020** (0.0009)	-0.0042** (0.0019)	0.1121 (0.1557)	-0.0019** (0.0008)	-0.0030* (0.0017)	0.0841 (0.1383)	-0.0016** (0.0007)	-0.0012 (0.0024)	0.2036** (0.0814)	-0.0016** (0.0007)	-0.0005 (0.0022)	0.1021 (0.0747)
	Population growth	0.6821** (0.3278)	-0.7849 (0.6175)	-2.5585 (1.7034)	0.7283** (0.3373)	-1.0765* (0.5621)	-1.3415 (1.5756)	1.0455*** (0.3266)	-1.0712* (0.6057)	0.3920 (1.5301)	1.0641*** (0.3425)	1.2790** 0.5782	1.4206 (1.6006)
	Trade openness	-0.0018 (0.0170)	0.0108 (0.0280)	0.0942* (0.0547)	0.0001 (0.0177)	0.0032 (0.0273)	0.1435*** (0.0508)	-0.0021 (0.0167)	0.0217 (0.0455)	0.1453*** (0.0525)	-0.0017 (0.0187)	0.0200 (0.0460)	0.1673*** (0.0440)
	Political rights		-0.7631** (0.3674)	-1.5175 (1.7321)		-0.7632** (0.3537)	-1.5261 (1.7133)		1.3501*** (0.5131)	-2.2708 (1.7706)		-1.2952** (0.4996)	-1.9167 (1.8195)
	Number of observations	911	450	109	911	450	109	677	319	94	677	319	94
	Number of countries	31	31	25	31	31	25	22	22	20	22	22	20
	Hausman test (p-value)	26.68 (0.0004)	47.19 (0.0000)	91.05 (0.0000)	52.74 (0.0000)	74.70 (0.0000)	NA	35.59 (0.0000)	25.05 (0.0015)	24.87 (0.0031)	33.20 (0.0001)	NA	15.53 (0.2753)

Legend: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
Source: Own computations.

When we use Total Factor Productivity (TFP) growth as *proxy* for economic growth (Models B), results do not greatly match those obtained for the GDP *per capita* growth. Thus, EEs' productivity dynamics are explained by distinct determinants.

In our *baseline* model, without and with interaction (Models B1 and B4), which covers the whole period (1961-2015), the only trade channel that has a significant and positive marginal effect on both growth models is the inward FDI flows (at a 5% significance level). Thus, we can only validate *H2* ("*EEs that receive higher inflows of FDI tend to present higher growth rates*"). On our *baseline* model with interaction (Model B4), human capital also has a positive and significant impact on growth (0.1585, p-value<0.1). In other words, *H4* ("*EEs highly endowed with human capital tend to grow faster"*) is corroborated. For the shortest periods, without interaction (1996-2015 – Model B2 -, and 2005-2015 – Model B3), all the estimated *core* variables have a non-significant *global* impact on growth. When we introduce the interaction terms the absorptive capability terms present a significant and positive impact on growth, most notably, through the interaction of inwards FDI flows with R&D domestic expenditures (3.72, p-value<0.01 – Model B6) and human capital (0.0911, p-value<0.05 – Model B5). Thus, the absorptive capability hypotheses *H6 (H2a)* ("*The higher the EEs' human capital stock, the stronger the impact of FDI on EEs' economic growth"*) and *H7 (H2b)* ("*The higher the EEs' R&D intensity, the stronger the impact of FDI on EEs' economic growth"*) are validated by our data.

Unexpectedly, the *direct* effect of inward FDI flows (Model B5), and human capital (Model B6) on economic growth is negative and significant. Notwithstanding, the *global* effect of these variables is non-significant and thus *H2 ("EEs that receive higher inflows of FDI tend to present higher growth rates")* and *H4 ("EEs highly endowed with human capital tend to grow faster")* cannot be corroborated.

4.2. Results according to income and regions

EEs are very heterogeneous countries both at the level of income - including countries with a low (e.g. Uganda), lower middle (e.g. Albania), and upper middle (e.g. Uruguay) income level -, and regions, including countries located in East Asia & Pacific plus South Asia, Europe and Central Asia, Latin America & Caribbean's, and North & Sub-Saharan Africa.

Beginning with the analysis by level of income for the real GDP *per capita* annual growth (see Table 5, Models A7-A9), we observe that for the low-income countries (Model A7), all the *core* variables have an insignificant *direct* and *global* marginal effect on growth. However, the *indirect* marginal effect of FDI on growth through human capital holds a positive and highly significant impact (0.179, p-value<0.01). This means that, low income EEs are only able to reap benefits from FDI if they possess a given positive level of human capital stock. In short, the absorptive capability hypothesis *H6* (*H2a) ("The higher the EEs' human capital stock, the stronger the impact of FDI on EEs' economic growth")* is validated.

In the case of the lower middle income countries (Model A8), the imports of capital goods have a *direct* positive and significant effect but an *indirect* (through human capital) negative significant marginal effect on growth, which renders a non-significant *global* effect of the imports of capital goods on these countries' economic growth. Thus, *H1 ("EEs that import more capital goods from technological advanced countries tend to present higher growth rates")* cannot be validated. In contrast, FDI inflows impact significant and positively (0.295, p-value<0.10) on the economic growth of lower-middle income countries. This means that *H2 ("EEs that receive higher inflows of FDI tend to present higher growth rates")* is validated by our data for lower middle income countries. Surprisingly, *H5 ("EEs that are highly intensive in R&D tend to grow faster")* is rejected as indigenous R&D has a very significant and negative impact (-14.110, p-value<0.01) on the economic growth of lower middle income countries.

In the case of upper middle income countries, the main hypotheses are strongly validated: EEs that import more capital goods from technological advanced countries (*H1*) or that receive higher inflows of FDI (*H2*) tend to present higher growth rates. Moreover, the impact of capital goods from technological advanced countries on EEs' economic growth is higher than that of FDI (that is, *H3* is true). The absorptive capabilities of upper middle income countries, namely in what respects to the absorption of FDI are critical for these countries' economic growth as the higher these countries' human capital stock (*H6/H2a*)/ R&D intensity (*H7/H2b*), the stronger the impact of FDI on their economic growth. It is interesting to note that although FDI has a positive and significant *global* impact on upper middle income countries' economic growth, its *direct* impact is (significantly) negative.

Table 5: Determinants of economic growth, panel data fixed effects by countries' income group and regions (marginal effects, robust standard errors in brackets)

		Income						Region							
		GDP *per capita* growth			TFP growth			GDP *per capita* growth				TFP growth			
		Low income countries	Lower middle income countries	Upper middle income countries	Low income countries	Lower middle income countries	Upper middle income countries	East Asia & Pacific plus South Asia	Europe and Central Asia	Latin America & Caraibeens	SSA +North Africa	East Asia & Pacific plus South Asia	Europe and Central Asia	Latin America & Caraibeens	SSA +North Africa
		Model A7	**Model A8**	**Model A9**	**Model B7**	**Model B8**	**Model B9**	**Model A10**	**Model A11**	**Model A12**	**Model A13**	**Model B10**	**Model B11**	**Model B12**	**Model B13**
International trade's direct impact	Imports of capital goods (in % GDP)	0.961	1.705*	9.067*	3.654***	0.244	14.286***	1.629	5.866**	18.970***	0.837	1.827	4.444*	9.892***	-0.827***
		(0.820)	(0.998)	(5.071)	(0.708)	(0.944)	(3.330)	(1.664)	(2.760)	(2.373)	(0.723)	(2.437)	(2.416)	(3.641)	(0.029)
	Inward flows of foreign direct investment (in % GDP)	-0.618	0.263	-7.715***	-1.492***	0.893	-10.34***	-2.198	-3.988*	-5.262*	-2.327**	-5.552**	-2.511	-3.723	0.678***
		(0.498)	(0.810)	(2.418)	(0.460)	(0.837)	(2.186)	(1.823)	(2.337)	(3.183)	(0.269)	(2.382)	(3.038)	(2.708)	(0.161)
Competencies	Human capital stock	0.984	0.999	-5.368	2.142**	1.753**	1.248	2.011	-2.129	4.289**	0.306	2.391	0.144	3.014*	-1.221**
		(1.075)	(0.475)	(6.539)	(1.042)	(0.721)	(4.937)	(1.540)	(1.864)	(2.080)	(1.706)	(2.157)	(2.312)	(1.737)	(0.565)
	R&D domestic expenditures in R&D (in % GDP)	2.982	-14.11***	3.863	18.988***	-21.591*	-11.678	-0.769	-18.109**	-7.187	-16.826**	9.028	-20.213**	-3.563	
		(4.376)	(4.457)	(19.180)	(6.691)	(11.098)	(11.780)	(2.079)	(8.586)	(23.728)	(5.156)	(8.023)	(8.331)	(11.160)	
Absortive capabilities	Interaction between human capital and the imports of capital goods ***(H6/H1a)***	-0.072	-0.226**	-0.666	-0.035	-0.252**	-1.419***	-0.277	-0.496*	-2.184***	-0.040	-0.363	-0.479**	-1.184***	0.148***
		(0.118)	(0.099)	(0.547)	(0.122)	(0.103)	(0.355)	(0.262)	(0.278)	(0.296)	(0.138)	(0.366)	(0.216)	(0.466)	(0.052)
	Interaction between R&D and the imports of capital goods ***(H7/H1b)***	-0.045	1.035	-2.562	-3.267***	3.155	0.124	0.671**	-0.467	4.391	0.414	0.184	0.639	-0.399	
		(0.545)	(0.697)	(1.950)	(0.861)	(2.190)	(1.058)	(0.323)	(0.901)	(5.595)	(0.522)	(1.737)	(1.091)	(3.394)	
	Interaction between human capital and foreign direct investment ***(H6/H2a)***	0.179***	-0.011	0.673***	0.246***	-0.041	0.880***	0.367	0.265	0.825*	0.346**	0.926**	0.155	0.569	-0.212*
		(0.056)	(0.057)	(0.158)	(0.079)	(0.061)	(0.159)	(0.305)	(0.196)	(0.479)	(0.058)	(0.412)	(0.255)	(0.451)	(0.122)
	Interaction between R&D and foreign direct investment ***(H7/H2b)***	-0.874	0.389	3.589**	-0.710	-0.364	4.144**	-0.685	3.388***	-6.490***	2.869**	0.594	2.446	-3.100	
		(1.334)	(0.948)	(1.689)	(1.259)	(0.941)	(1.802)	(1.836)	(1.243)	(2.262)	(0.357)	(2.306)	(1.589)	(3.459)	
Global impact	Imports of capital goods (in % GDP) ***(H1)***	0.516	0.062	1.170***	1.168***	-0.825*	0.223	0.212	0.683***	2.226***	0.782***	-0.420	-0.077	0.201	-0.465***
		(0.378)	(0.323)	(0.313)	(0.334)	(0.461)	(0.383)	(0.462)	(0.185)	(0.292)	(0.254)	(0.717)	(0.207)	(0.667)	(0.127)
	Inward flows of foreign direct investment (in % GDP) ***(H2)***	-0.035	0.295*	0.764**	-0.491	0.397*	0.475	-0.206	0.194	-0.010	-2.219	0.849	0.210	0.204	0.162
		(0.436)	(0.184)	(0.397)	(0.814)	(0.244)	(0.438)	(0.587)	(0.214)	(0.581)	(2.347)	(1.119)	(0.201)	(0.521)	(0.163)
	Human capital stock ***(H4)***	1.267	-0.233	-7.486	2.610***	0.266	-5.263	1.477*	-3.903***	-1.253	1.669	2.806**	-2.065	0.463	-1.057***
		(0.843)	(0.513)	(5.449)	(1.000)	(0.556)	(5.150)	(0.907)	(1.137)	(1.257)	(1.355)	(1.379)	(1.425)	(1.603)	(0.314)
	R&D domestic expenditures in R&D (in % GDP) ***(H5)***	0.301	-7.148	-0.689	7.408	-6.586*	4.120	0.957	-7.112	-14.038	0.205*	11.158**	-6.485	-16.679***	
		(3.049)	(4.527)	(13.414)	(6.283)	(3.753)	(8.381)	(3.074)	(5.764)	(8.849)	(0.120)	(4.739)	(5.869)	(5.389)	
Control variables	Government expenditure in GDP	0.021	-0.543***	0.165	0.113	-0.462*	-0.243	-0.125	-0.449**	-0.047	0.064	0.189	-0.457***	-0.112	-0.154**
		(0.083)	(0.177)	(0.498)	(0.115)	(0.270)	(0.390)	(0.161)	(0.186)	(0.262)	(0.172)	(0.376)	(0.176)	(0.211)	(0.079)
	Inflation	-0.055*	-0.006***	-0.015	0.118*	-0.004	-0.052	-0.059	-0.004**	0.183***	-0.087**	0.074	-0.001	0.032	0.007
		(0.030)	(0.002)	(0.057)	(0.061)	(0.003)	(0.041)	(0.080)	(0.002)	(0.037)	(0.041)	(0.088)	(0.002)	(0.027)	(0.008)
	Population growth	1.932	-2.074***	-0.280	6.194	-1.145**	0.571	3.759	-1.175	7.389*	0.562	6.491***	-0.938	12.296**	-0.496
		(4.481)	(0.644)	(2.093)	(5.724)	(0.564)	(2.057)	(2.478)	(0.998)	(4.402)	(3.763)	(2.002)	(0.844)	(5.487)	(0.333)
	Trade openness	0.070	0.062	0.248***	0.064*	0.092	0.245***	0.077	0.082	0.329**	-0.021	0.056	0.105	0.323***	0.067***
		(0.074)	(0.054)	(0.072)	(0.037)	(0.092)	(0.085)	(0.054)	(0.060)	(0.136)	(0.072)	(0.079)	(0.080)	(0.032)	(0.023)
	Political rights	1.918***	-0.724	-3.453	3.497***	-1.224*	-3.075	0.402	-3.767***	-1.011*	1.352	0.263*	-4.607***	-1.229***	
		(0.880)	(0.614)	(3.122)	(1.145)	(0.641)	(2.194)	(0.493)	(1.373)	(0.552)	(1.220)	(0.154)	(1.056)	(0.324)	
	Number of observations	68	130	61	45	115	61	61	132	36	30	51	122	36	92
	Number of countries	12	12	5	6	10	5	9	10	4	6	5	9	4	3

Legend: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; *Source:* Own computations

In a nutshell, upper middle income countries' economic growth can only be enhanced by FDI if these countries possess a given positive level of human capital and R&D intensity, that is, adequate absorptive capacities.

When we use **Total Factor Productivity (TFP) growth** as a proxy for economic growth, the results for the low-income countries are drastically more significant. First of all, imports of capital goods (in % GDP) have a *direct* and *global* positive marginal effect. Secondly, inward FDI flows has again a negative and significant (at 1 % significance level) marginal *direct* effect on growth, but a positive and significant (1% level) *indirect* effect through this variable's interaction with the human capital stock. Finally, regarding the internal competencies variables, human capital and R&D domestic expenditures have, besides the indirect previously referred, a *direct* positively significant impact. Thus, all the remaining factors being held constant, low income countries tend to growth faster when their adult population is highly educated and their R&D intensity is larger. Moreover, human capital's impact is paramount with its marginal effect being also *globally* significant for productivity growth.

For the lower middle income countries, the R&D domestic expenditures variable exhibits a significant *direct* and *global* negative effect on growth (at a 10% significance level). Moreover, the imports of capital goods also have a significant negative *global* and *indirect* (through human capital) impact on TFP annual growth. Human capital has a significant and positive *direct* effect on growth (1.753, p-value<0.05), but not in global terms. For this group of countries TFP growth is stimulated mainly through the inflow of FDI. On average, lower middle income countries that observe a 1 per cent increase in their FDI inflows, ceteris paribus, experience a 0.4 percentage points in TFP growth.

Regarding the upper middle income countries, no main growth driver emerges as *globally* relevant for TFP growth. The growth of productivity only results from the absorptive capabilities channel, particularly when involving FDI. Thus, for this group of countries *H1-H5* are not corroborated but *H6 (H2a)* and *H7 (H2b)* are. Additionally, the imports of capital goods have a significant *direct* and positive (14.286, p-value<0.01) marginal effect on growth, whereas the FDI *directly* harms TFP growth of these countries.

Analysing the estimation results according to world regions, and beginning with the real GDP *per capita* (Model A10-Model A13), we observe distinct patterns among regions in what regards knowledge, trade and absorptive capacity determinants.

Indeed, for the East Asia & Pacific plus South Asia region (Model A10), the *core* variables fail to *directly* impact on countries' economic growth, albeit the *indirect* impact of imports of capital goods through R&D domestic expenditures emerges as significant and positive (0.671, p-value<0.05) in accordance with the absorptive capability hypothesis, *H7(H1b)* ("*The higher the EEs' R&D intensity, the stronger the impact of capital goods from technological advanced countries on EEs' economic growth"*). The only core variable that significantly impacts, at a *global* level, on the economic growth of EEs located in East Asia & Pacific plus South Asia region is human capital (1.48 marginal effect, p-value <0.10). So, a high level of formal schooling is the critical determinant of the GDP *per capita* growth of EEs in in East Asia & Pacific plus South Asia region. Thus, *H4* is validated in the case of the countries located in this region.

The estimation results for Europe and Central Asia (Model A11), Latin America & Caraibeens (Model A12) and Sub-Saharan Africa plus North Africa (Model A13) show some similarities. The imports of capital goods present a *global* positive and highly significant (1% level) effect on all the three groups of regions and a significant positive *direct* and negative *indirect* (trough human capital) marginal effect on the economic growth of Europe and Central Asia (Model A11) and Latin America & Caribbean's (Model A12). For all the three regions (Model A11-A13), the inward FDI flows have a significant and negative *direct* effect on economic growth, meaning that a one percent change in FDI inflows leads to a given percentage decrease in economic growth.

Additionally, in Europe and Central Asia (Model A11) and in Sub-Saharan Africa plus North Africa (Model A13), a one percent change in R&D domestic expenditures generates a 18.1 (Model A11) and a 16.8 (Model A13) percentage point decrease in economic growth (at 5% significance level), but a significant and positive marginal effect on growth when interacted inward FDI flows. Thus, the impact of FDI inflows on economic growth is stronger the higher the internal R&D intensity, resulting in the validation of *H7 (H2b).*

In the case of countries located in Latin America & Caribbean's region (Model A12) and the Sub-Saharan Africa plus North Africa region (Model A13), on average, countries that receive higher inflows of FDI growth as faster as the higher their knowledge endowments (i.e., their levels of schooling and R&D intensity, this latter only in the case of SSA plus North Africa region). Interestingly, and unexpectedly, R&D intensity *global* impact is only statistically significant, and positive, for SSA plus North Africa region which corroborates *H5*.

Results regarding the global impacts of the *core* variables are particularly distinct when we analyze Total Factor Productivity (TFP) growth as *proxy* for economic growth (see Table 5, Model B10- Model B13) compared to those obtained for the GDP *per capita* growth (Models A7-A10).

For the East Asia & Pacific plus South Asia region (Model B10), inward FDI inflows has a *direct* negative and significant marginal effect on growth (-5.552, p-value<0.05) but a positive (0.926) *indirect* (trough human capital) marginal effect on growth at a 5% significance level, hence corroborating *H6 (H2a)* ("*The higher the EEs' human capital stock, the stronger the impact of FDI on EEs' economic growth"*). The internal competencies, human capital stock and R&D domestic expenditures, both possess a positive marginal effect on growth at a 5% significance level, thus corroborating both *H4* and *H5*.

The estimations for the European and Central Asian region (Model B11) present a 4.44 marginal *direct* effect (10% level of significance) for imports of capital goods (in % GDP) but a negative and significant impact when interacted with human capital, which results in the rejection of *H6 (H1a)* ("*The higher the EEs' human capital stock, the stronger the impact of capital goods from technological advanced countries on EEs' economic growth"*). Also, R&D expenditures have a negative (-20.213) *direct* effect on growth, at a 5% significance level. Moving for the Latin America & Caribbean (Model B12) results estimate that imports of capital goods and human capital have, individually, a positive and significant *direct* marginal effect, but a negative and highly significant (1% level) marginal *indirect* effect when interacted with each other (that is, *H6/H1a* is rejected). As for the *global* effects, results show that R&D domestic expenditures have a highly significant (1%) negative (-16.679) impact on growth, meaning that the *H5* does not hold for the Latin America & Caribbean region.

Finally, results for the Sub-Saharan Africa plus North Africa (Model A13) region show that imports of capital goods and human capital stock both *directly* impact growth negatively at a 1% and 5 % significance level, respectively. Albeit, if combined, this two variables generate a positive (0.148) marginal effect on growth, at a very consistent 1% significance level (*H6/H1a* is validated). .

Notwithstanding, when we interact inward FDI flows (*direct* marginal effect: 0.678, p-value<0.01) also with human capital the interaction comes out negative (-0.212) and significant (10% level). Hence, the absorptive capability hypothesis, *H6 (H2a)* cannot be corroborated for the Sub-Saharan Africa plus North Africa region. For the *global* impact of our *core* variables the obtained estimations clearly point out that imports of capital goods and human capital stock have a negative and highly significant (1% level), resulting in the rejection of *H1* and *H4*.

4.3. Discussion

The obtained results for the *baseline* (with and without interaction) model (1961-2015), for economic growth proxied by real GDP *per capita* annual growth, indicate that imports of capital goods (in % GDP) and inward flows of foreign direct investment (in % GDP) have a preponderantly positive impact on economic growth. These results meet the literature expectations that imports of capital goods do have a key role in helping less technologically developed countries achieving economic and technological development through international diffusion of spillover effects and productivity improvements (Lee, 1994; Krammer, 2010; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014; Cuadros and Alguacil, 2014) and foreign direct investment inflows (Li and Liu, 2005; Batten and Vo, 2009; Wang, 2009; Kramer, 2010; Su and Liu, 2016). Additionally, the impact of imports of capital goods has a larger effect on growth than the inward flows of FDI, which is in accordance the empirical findings of Krammer (2010) and Glas et al. (2015).

When we use TFP annual growth as a proxy for economic growth, the conclusions for the *baseline* model reinforce the overall importance of foreign direct investment inflows and introduces human capital as a significantly positive variable, as predicted by the existing literature (e.g. Schultz, 1961; Becker, 1962; Temple and Voth, 1998; Krammer, 2010; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014) that envisions human capital stock as a determinant vehicle that facilitates the adoption of international advanced technology.

Moving forward to the shorter and more recent time periods (1996-2015, 2005-2015), the estimations present very consistent results for the absorptive capacity by emphasising again the importance of foreign direct investment inflows on productivity and output growth, most notably when interacted with the human capital stock and R&D domestic expenditures in R&D (in % GDP). This highlights the role of internal capabilities in the absorption process of international frontier technology for EEs in line with extant literature (Abramovitz, 1986; Benhabib and Spiegel, 1994; Borensztein et al., 1998; Xu, 2000; Batten and Vo, 2009; Teixeira and Fortuna, 2010; Banerjee and Roy, 2014; Elmawazini, 2014).

Our results uncover an overlooked issue by the studies that have addressed EEs economic growth: the heterogeneity /distinct growth patterns among EEs, most notably among low-high income countries and countries located with distinct world regions.

The results for the low income countries evidence that the interaction between human capital and FDI holds a relevant impact on both productivity and output growth, hence meeting literature's expectations that such countries need to reach a human capital threshold in order to benefit from technological transferences from more technological sophisticated countries (see Borensztein et al., 1998; Xu, 2000; Batten and Vo, 2009). Additionally, productivity in low income countries and contrasting with other income groups, is strongly stimulated by two core variables: human capital and imports of capital goods. Available literature for the African continent (composed mostly by low income countries) highlights the importance of human capital on economic growth (see Akinlo, 2004; Gyimah-Brempong, Paddison and Mitiku, 2006). Furthermore, Schultz (1989) emphasises the importance of schooling and human capital for low income countries to achieve economic growth.

Regarding the middle income countries (lower and upper middle) there is a clearly predominant positive impact of inward FDI flows on productivity and output, particularly for the lower middle income level. Notwithstanding, the upper middle income countries tend to benefit from FDI to a larger extent when they possess a give level of both human capital and R&D intensity, that is, possess adequate internal absorptive capabilities.

Regarding location, we found the existence of asymmetries among regions concerning the determinants of economic growth. The results for the *core* variables evidence that the imports of capital goods (in % GDP) have a pivotal role in promoting real output growth in all regions, except in the East Asia & Pacific plus South Asia regions. As for the competencies variables, results show that R&D intensity stimulates economic growth not only in East Asia & Pacific plus South Asia, but, and at the first glance, surprising, in the North & Sub-Saharan Africa region. Existing literature available for developing countries and emerging economies (e.g. Kim, 2011; Gyekye, Oseifuah, and Vukor-Quarshie, 2012; Gumus and Celikay, 2015; Inekwe,2015) found a positive relation between R&D domestic expenditures (both public and private) and economic growth in developing and emergent economies.

Hu and Mathews's (2005) research has shown that R&D expenditures have been accompanied by increases in patenting rates in East Asia, being interpreted by the author as a source of a meaningful increase in innovation activities. The source of latecomers' innovative capacity, according to Hu and Mathews (2005), is related not only to the extremely relevant private R&D, but also to public R&D expenditures that have played a key role in guiding the East Asian on how to utilize their limited resources and finding specialization.

Moreover, human capital has a relevant impact on economic growth on the East Asia & Pacific + South Asian regions. Empirical studies for China (East Asia & Pacific) have highlighted the role of human capital as an important stimulant of productivity and output growth (Wang and Yao, 2003; Fleisher, Li, and Zhao, 2010). Indeed, Fleisher et al. (2010) argues that the level of education of the population has a *direct* (through worker's skills and domestic innovation activities) and *indirect* (trough technological spillover effects on Total Factor Productivity growth) considerable impact on economic growth. Foster and Rosenzweig's (1996) findings for India (South Asia) reinforce the idea that a more educated population is more likely to better absorb new technologies, facilitate productive innovation and take advantage of technical progress. Most importantly, empirical results for South Asia (India and Pakistan) have also found a positive relation between the human capital proxy and economic growth (Abbas, 2000).

5. Conclusion

The present dissertation based on three panel data sets for 39 Emergent Economies (as classified by Saccone (2017)) over a long (54 years: 1961-2015), intermediate (19 years: 1996-2015) and a short (10 years: 2005-2015) period of time, aimed to test the "absorptive" capacity hypotheses by analysing the impact of Trade, FDI, Human capital, R&D and their interactions on economic growth (measured by productivity and output *per capita* growth). Furthermore, it also accounted for panel data's heterogeneity by analysing the absorptive capacity of the 39 EEs according to their income and geographical groups.

Main contributions

The main contributions of the present dissertation are three fold.

First, it helps to disentangle the relative importance of knowledge endowments (human capital and R&D) and trade (FDI, and imports of capital goods) in EEs' long run growth.

As others before us have shown, albeit focusing on less developed countries' growth (see Coe et al., 1997; Fagerberg, 1994; Krammer, 2010), the imports of machinery and equipment emerged as an important carrier of technological development and productivity growth to EEs, particularly in terms of real GDP per capita growth for the whole period in analysis (1960-2015). This confirms extant evidence (see Lemoine and Ünal-Kesenci, 2004) that, in line with other countries (Teixeira and Fortuna, 2010; Banerjee and Roy, 2014), EEs use the trade of intermediate goods as a channel to acquire new frontier technology, being later introduced in their production processes as technological advanced inputs, which then results in the development of new products and new skills and competences.

Although for the whole period (1960-2015) the impact of capital goods imports from technological advanced countries on EEs' economic growth is higher than that of FDI, confirming some extant evidence for some developing countries across Africa, Asia, and Latin America (Neelankavil et al., 2012), for the most recent periods (1996-2015 and 2005-2015), EEs' most important growth pushers (both for GDP per capita and TFP) are the absorptive capacities, most notably the interaction between human capital/R&D and foreign direct investment. Thus, as several studies highlighted for other countries (e.g., Teixeira and Fortuna, 2010; Banerjee and Roy, 2014; Su and Liu, 2016), in the more recent periods there is strong evidence of the importance of human capital and domestic investments in R&D for EEs in their absorption process of spillovers that come from FDI. In this vein, for the EEs multinational corporations seem to be crucial to spread technology world-wide, being an important vehicle of technology improvement to EEs by promoting the transmission of advanced technologies and managerial skill (Borensztein et al., 1998; Forte and Moura, 2013).

Summing up, we demonstrate that in the case of EEs as a whole, from 1996 onwards, a certain threshold of human capital and/or internal R&D is necessary to absorb international frontier technological spillovers, namely those that emerge from FDI inflows.

Second, it discloses how human capital and R&D interact with trade (i.e., country's absorptive capacity) and impacts on long run economic growth of EEs.

Our results show that for EEs to absorb the technology embodied in imports or FDI it is necessary to build technological domestic knowledge and capacities driven by human capital and indigenous R&D investments to learn, assimilate and replicate the technology embodied in these trade channels. This corroborates other studies (Dulleck and Foster, 2008; Fu et al., 2011), which underline that technology diffusion through trade cannot be successful on its own, but it is rather the result of a complementary relation between the internal efforts to develop absorption capacities plus the international spillovers that come from foreign frontier technology.

Our results for the most recent periods (1996-2015 and 2005-2015) support the contend that the creation of a domestic threshold of human capital is a vital condition for EEs' absorptive capacity of FDI spillovers by contributing to reduce the 'knowledge gap' between the recipient country and the developed world. It is likely that the presence of multinationals contributes to enhance human capital formation by providing training to the local labor force (Teixeira and Shu, 2012; Teixeira and Lehmann, 2014), permitting the strategic restructuring and upgrading of equipment and production processes, and the introduction of new products and processes (Konings, 2000; Un, 2016), and ultimately to enhance economic and total factor productivity growth.

Third, it uncovers profound heterogeneity of EEs' growth paths by providing an in depth analysis of long run growth determinants by group of income (low, medium, medium-high income) and world regions (East Asia & Pacific plus South Asia, Europe and Central Asia, Latin America & Caraibeens, and North & Sub-Saharan Africa). Although there are some studies that have analyzed EEs in this regard, they only analyzed the BRIC (Brazil, Russia, India, and China) as a whole (Glas et al., 2016) or focused on one of EEs individually (e.g., India - Banerjee and Roy, 2014; China - Su and Liu, 2016). They thus disregarded EEs' heterogeneity.

Policy implications

The obtained results for our estimations imply that in order for Emergent Economies to close the technological gap and promote economic and productivity growth, these countries should open their borders to trade (e.g., imports of capital goods such as machinery, equipment and transportation) and FDI (e.g., inward foreign direct investment flows) as a vehicle to acquire technology only available in more devolved countries. Moreover, countries' policies should promote the creation of a threshold of internal absorptive capacities capable of taking advantage of the acquired frontier foreign technologies. Those policies should focus on building internal competencies which implies the necessity of investing on improving human capital (mainly through education) whose input on economic growth tend to be scarce in less developed countries due to insufficient schooling (Schultz,1989). In developing countries (e.g. low income countries) investment in primary schooling is priority to raise the quality of human capital and promote economic growth (Schultz, 1989; Psacharopoulos, 1994).

Additionally, investing in technology/knowledge intensive-activities (e.g. indigenous Research and Development activities – both public and private) not only helps EEs to better understand advanced technology and learn from foreign technological sophisticated capital goods, but also helps them develop their own innovation activities.

Limitations and paths for future research

A countries' internal human capital stock is a very difficult variable to measure, being often poorly *proxied* in empirical growth research (Wößmann, 2003). Among the different flawed sets of measurements, educational attainment accounts for the total amount of formal education possessed by the labour force and provides the best available information on a country's internal level of human capital stock (Teixeira and Fortuna, 2010). Thus, the present dissertation used the average years of schooling of the working-age population as a *proxy* for the human capital. However, this *proxy* is far from being considered a perfect measurement of a countries' level of human capital stock. The average years of schooling as a *proxy* for human capital by quantifying the analyses on human capital, gives the same weight to any year of schooling, despite the schooling system in which it has taken place, hence neglecting the quality and efficiency of the educational system (Wößmann, 2003). This analysis considers that increases in productive human capital by year of schooling is the same, despite the cross-national education system differences in which the individuals are enrolled. Indeed, the quality of education differs across countries which means that the cognitive skills and knowledge acquired by the labour force in one year of schooling is different depending on the educational system in question (Wößmann, 2003; Hanushek and Wößmann, 2007). Pritchett's (2001) results emphasises that the contributions of education on growth have been very disappointing and very different across world regions which might be explained by the lack of educational quality in many countries that were (and still are) unable to transmit productive cognitive skills and knowledge to the labour force that can positively impact productivity and economic growth.

Moreover, other problems arise from this *proxy*, as it considers that the productivity differentials between workers is proportional to their years of schooling which might neglect the decreasing returns by the level of schooling (Psacharopoulos, 1994; Wößmann, 2003).

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Appendix

Table A 1: Correlation matrix between all the variables used in our models (1961-2015, 1996-2015, 2005-2005)

	GDPpcg	*TFPg*	*ImpK*	*FDI*	*HC*	*R&D*	*Government expenditures*	*Inflation*	*Population growth*	*Trade openness*	*Political rights*
GDPpcg	1										
TFPg	0.7912	1									
ImpK	0.1056	0.0537	1								
FDI	0.1565	-0.0084	0.3136	1							
HC	0.0940	0.2174	0.2537	0.2550	1						
R&D	0.1832	0.0030	0.1036	-0.0630	-0.1170	1					
Government expenditures	0.0195	0.0244	0.3292	0.2114	0.5489	0.1736	1				
Inflation	-0.1059	-0.0882	-0.1173	0.0149	0.0099	-0.0153	0.0313	1			
Population growth	-0.1158	-0.2081	-0.3619	-0.1348	-0.7532	-0.0860	-0.7340	-0.0403	1		
Trade openness	0.1327	0.1761	0.7067	0.3521	0.4174	-0.0813	0.4935	0.0223	-0.5343	1	
Political rights	0.1731	0.0473	-0.2909	-0.0429	-0.1641	0.0804	-0.3185	-0.0287	0.2827	-0.1622	1

Note: Grey cells indicate values greater than 0.7 and smaller than -0,7.
Source: Own computation

Table A 2: The Variance Inflation Factor (VIF) test for the *baseline* model (*GDPpcg*: 1961-2015)

Variables	***VIF***
Population growth	2.58
HC	2.53
Trade openness	1.88
ImpK	1.76
Government expenditure	1.47
FDI	1.36
Inflation	1.05
Mean VIF	**1.80**

Source: Own computation

Table A 3: Heteroskedasticity tests applied to the *baseline* model (*GDPpcg*: 1961-2015)

Test	**Chi2**	**p-value**
Breusch-Pagan/Cook-Weisberg	57.00	0.000
White	245.95	0.000

Source: Own computation